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J. M. STEVENS, B.Agr.Sc.,
Box 1928R, Melbourne, C.1.

Assistant Editor:
P. F. BUTLER, M.Agr.Sc.,
C/o C.S.I.R.O., 314 Albert Street,
East Melbourne, C.2.

Business Manager:
T. C. BELL, B.Agr.Sc.,
C/o C.S.I.R.O., 314 Albert Street,
East Melbourne, C.2.

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ARTICLES

CONCLUSIONS FROM SOME RECENT RESEARCH INTO ANIMAL BREEDING

By J. M. RENDEL

Introduction

Mendel, in his original studies, was able to isolate certain characters which are inherited as units and depend on the action of single genes. These are often completely dominant or recessive in which case the offspring of heterozygotes are produced in simple mendelian ratios. Aa by Aa gives 1AA, 2Aa, 1aa and if A is dominant you have three dominants to one recessive. As the number of genes increases the ratios become more complicated. Aa, Bb, Cc by Aa, Bb, Cc give a ratio of 27:9:9:9:3:3:3:1 assuming the capitals are dominant. When the environment enters in to give the same sort of variation as the genes mendelian analysis is no longer possible. Milk yield is much affected by feeding. It is also affected by genes but it is not possible to distinguish genetic from environmental effects.

Concept of Heritability

Most work of recent date on animal breeding has been directed towards solving the problems of breeding for characters whose variation is due to the combined action of several genetic and non-genetic factors. Variation of the two different kinds, genetic and non-genetic, is normally not distinguishable in individual animals; the techniques evolved as a result of the work of Sewall Wright and R. A. Fisher, estimate the average situation, so that though one cannot say whether any individual owes its peculiar characters to genetic or environmental causes, one can say that on average, a certain fraction of a departure from normal in a particular direction will be genetic in origin. This is the concept of heritability. If the heritability of egg yield over a full year is 5 per cent. this means that, on average, only 5 per cent. of deviations from mean annual yield are heritable, and if two hens mated to the same cock yield 200 and 300 eggs a year respectively, their daughters will differ, on average, not by 100 eggs but by 2.5, the dams differing genetically by 5, the sire being the same for each.

Additive Gene Action

The concept is a simple one which can be used to predict the effect of different breeding programmes on a character once its heritability is known. But such predictions are only useful if the type of genetic variation at work is additive. Additive genetic variation is such that the substitution of a gene has the same effect on the character no matter what the environment or other genes present, i.e., it always adds or subtracts a definite amount. Sometimes a gene substitution appears to multiply the character by a certain amount instead of adding, but so long as its effect is always the same it can be made additive by choosing a suitable scale. A gene which always multiplied by a fixed amount would be additive if all measurements were converted to logarithms.

Sometimes effects of genes are definitely not additive. A dominant gene, for example, has no effect when substituted for its recessive allele in a heterozygote, but has the full effect when

J. M. RENDEL, B.Sc., Ph.D., is Officer-in-Charge, Animal Genetics Section, C.S.I.R.O., Sydney.

substituted in a double recessive. Such genes can be looked on as having a certain fraction of their action additive, the rest not. The fraction which is additive depends on the frequency of the gene. Where the dominant is very rare its effect is almost completely additive. In some cases the gene's effect is so bound up with the presence of other genes that it is not additive at all. The effects of additive genes can be predicted, the effects of non-additive genes cannot.

So long as the additive component of genetic variation is large the concept of heritability will enable one to predict most of the possible genetic changes that will result from given breeding programmes. In some populations a search has been made for non-additive genetic effects. None could be detected in the inheritance of weight in rabbits, nor in the inheritance of milk and fat yield in dairy cattle. The method used to detect non-additive genetic effects was to look for "nicking", i.e., special combining ability. None was found in the two cases cited. In the special population of hybrid maize nicking does definitely play an important role, but inbred maize strains have been developed to make maximum use of it.

It is possible to estimate the upper limit of non-additive genetic variation by accounting for as much of the variation as possible and seeing what is left. For example, in milk yield, 50 per cent. of variation to be found between animals of the same herd is of a sort which causes the successive lactations of the same cow to differ from one another, apart from the systematic effects of age. If a cow's first lactation were a perfect measure of all future lactations then two cows which have a first lactation of the same amount will yield the same in all future lactations. They don't in practice, due to environmental effects acting differently on them. The correlation between first and subsequent lactations is about 50 per cent. and is called the repeatability of the trait. It measures the extent to which a ranking of cows on their first lactation would predict the ranking on their second. Thus half the variation is due to immediate environmental effects. The additive genetic fraction, found as the response to selection in one generation, accounts for about 30 per cent., leaving 20 per cent. to cover non-additive effects and environmental effects of a permanent kind such as would intervene before the first lactation and affect all subsequent ones. Pneumonia when a calf, for example.

The predictability of selection experiments from heritabilities calculated separately also gives an indication of the extent of interference of non-additive effects. The total failure to detect such effects on the one hand (maize excepted) and the extent to which variation can be accounted for without culling on such effects on the other, leads to the assumption that, for the time being, non-additive genetic effects can be ignored, and so long as there is absence of indications to the contrary we can asume that most genetic variation is additive.

Design of Breeding Programmes

Heritability of a large number of characters has now been measured. Milk yield, fat yield, fat content, rate of gain and economy of gain in pigs and beef cattle, conformation in pigs, egg laying (various measures) in poultry, shank length in poultry, fleece weight, body weight, and all the important fleece characters in sheep, to mention the most important, have been measured and many others besides. Of course, the heritability, which measures the genetic variation as a fraction of the total, is not necessarily the same for the same trait in all populations. In general it has been found that estimates made on different populations have agreed well, but it should not be assumed that they will or ought to do so, some populations may be genetically more variable and some have a more varied environment than others.

It should be possible to design breeding programmes for the exaggeration of all the characters listed, and to predict their

effect. The prediction will only hold so long as the genetic situation remains the same, i.e., so long as selection does not bring about a position in which the heritability is no longer as at the beginning of the programme, and so long as the population has not been changed in some other way.

It has been found in laboratory experiments (Mather (1949), Robertson and Reeves (1950), etc.) that the situation has remained the same and selection has continued to have the expected effect for a varying length of time.

Some populations have continued to respond much longer than others, but all have responded well for at least 10 generations, and all have in the end run into snags. The snags have not been fully elucidated as yet but their general nature seems to be as follows. At the beginning of the selection programmes the simple gene effects are picked out and advance in the direction of selection is not accompanied by any untoward occurrences, but as events proceed, the only variation left is that due to genes, or blocks of genes, with unwanted associated effects, so that further exaggeration of the desired character is accompanied by exaggeration of some undesired one. The undesired one is often lack of fertility or inviability. The experiments cited are done with *Drosophila* and other laboratory animals, and there may well be other associated effects not important in the laboratory which would be agriculturally harmful if we suppose the situation transferred to a domestic mammal.

The heritability concept can be used to predict the effect of breeding programmes with these reservations:—that the heritability is calculated for the population to be selected; that the prediction will be true for 10 generations, possibly more, but not indefinitely; that variation of the character proves to be controlled mainly by additive genes.

Some Practical Examples

So far few selection programmes based on calculations of heritability have been worked out for domestic animals, and fewer still have been executed. The outstanding exception is the poultry breeding scheme of Dr. I. M. Lerner (1950). The character chosen was the number of eggs laid by each hen going into the laying house in a year regardless of its survival. This is called the hen housed average for short. It has a heritability of only 5 per cent. If the sole criterion of selection were a hen's own performance, advance would be intolerably slow; cocks would remain an unknown factor and even hens an almost unknown one. But the performance of a sibship can be averaged to give a judgment of the genetic level of the family, which has quite a high degree of accuracy. If 95 per cent. of all variation is non-genetic and at random, then taking the mean of two birds will halve this fraction, the mean of three or four divide it by three or four as the case may be. For this reason the family average has a higher heritability than that of the individual because the non-genetic variation is reduced to a fraction depending on the number in the family, but the genetic variance of the family mean is not. As the cock has the same genetic value as his sisters, on average, selecting on the family average allows selection to be made between cocks. Progeny testing was found not to be profitable as it increased the length of generation. It did provide a more accurate way of selecting between cocks and so increased the rate of advance in a generation, but the number of generations got through in a given time was so reduced that the advance in a year was actually less. Lerner increased the hen housed average of his flock from 120 eggs a bird to 220 eggs a bird in twelve years. The score when last heard of was still going up. His selection combined the use of family averages and individual scores which were weighted to give the greatest advance. The advance obtained followed closely the predicted one.

An analysis of dairy herds and dairy cattle breeding was made by Rendel and Robertson (1950). The breeding scheme evolved as a result of the analysis has not yet been put into effect but there is every hope that it will be in time. In this analysis it was shown that the maximum advance by selecting cows on their own performance and bulls on their dam's performance was about 0.6 per cent. of the mean yield in a year. This is due partly to the lack of distinction between bulls, so that all effective selection is between cows, and partly to the low reproductive rate which means that only a small fraction of the female population can be culled if numbers are to be maintained. It was found that progeny testing enabled bulls to be ranked in order of merit with quite a high heritability, but progeny testing puts up the generation length so that it is unprofitable in herds of less than 100, and only really profitable in herds reaching 500 milking cows. At artificial insemination centres the profitability is at a maximum. Not only are populations large, reaching 10,000 or more in one breed, but the station is laid out to make progeny testing easy. It was estimated that if artificial insemination centres would breed their own bulls from their own progeny tested bulls out of the best cows in their panel, the rate of increase in yield of milk or fat could be nearly three times the theoretical maximum without progeny testing, i.e., would be 1 per cent. to 1.5 per cent. in a year.

It is true that the cost of progeny testing and breeding bulls for a 5,000 unit might be high, any figure would be a guess without specifying the conditions, it might cost as much as £10,000 in a year in Australia, including cost of recording cows and calf marking and housing bulls awaiting test, but the return would be much greater. By the tenth year the increase in annual yield would have been about 10 per cent., i.e., 50 gallons on to the average yield of the cows in the whole population, assuming they average 500 gallons at lactation at the start. This is an increase of 250,000 gallons in annual yield, which remains for all time, assuming no change in management; at present prices it is worth about £52,000. By the tenth year then the value of a year's yield is up by £52,000 and is increasing at a rate of £5,200, i.e., by the eleventh year annual yield will have increased by £57,200. At the start, until some of the daughters of selected bulls begin to yield there will be no effect from the breeding programme, but once it starts to come into effect all gains are cumulative.

These two examples illustrate the way heritability analysis can be used to direct selection. In the poultry example, progeny testing does not pay, in the cattle case it does. Similar programmes could be calculated for sheep and pigs.

In some countries, notably Denmark, practical measures have been taken without consideration of theoretical analysis. The Danes, early after the first world war, set up an extensive litter testing scheme for their pigs. The result of the tests was published and showed how litters compared with respect to all those traits—back and belly fat (in cm.), length (in cm.), No. of ribs, weight, size of ham, etc.—which were important to the English bacon market. No steps were taken to see that any notice was paid to the test, this was left to the breeder, so that the exact effect of selection cannot be followed. One can only say that today the Danes have the finest bacon pig which is the most prolific breeder in the world.

The Danes also set up a bull testing scheme for their Danish red dairy cattle. This is now carried out on specially selected farms where the progeny of three or more bulls can be compared side by side under controlled conditions. Again the result of the tests are made known and nothing further is done, so that one can only comment that as a breed the Danish red has a very high level of production. If not the best, it is amongst the leaders for total fat yield, and, in addition, supplies Denmark with

meat. The Danes have taken the important step of measuring accurately the economic value of their animals. If in addition the breeding programme had been selected to give the best results they might have advanced more rapidly to their present position.

Some Considerations of Breeding Policy

We have now looked briefly at the contribution scientific animal breeding can make to those who are actively engaged on breeding improvement. Whereas in poultry, and also in sheep and pigs, the individual breeder has sufficient animals to carry out constructive breeding, in dairy cattle few herds reach 500 and the artificial insemination centre is the obvious breeding unit. In the absence of such a breeding unit a co-operative effort, perhaps under the ægis of a breed society, designed to provide a large enough population under one direction, would be the next best thing.

The people who have the responsibility of moulding the characteristics of a breed of livestock are the ones most concerned with selection and breeding programmes, and the application of genetics tells one the kind of breeding programme and breeding unit which are needed to achieve results. The commercial man is usually content to leave constructive breeding to the stud masters; his problem is how to select sires for his purposes from the studs and how much to pay for them. Genetic analysis can tell the commercial breeder two things. First, the extent to which the difference between the performance of his animals and that of the stud masters is genetic, and, second, the extent to which buying from different sources is likely to affect his flocks or herds.

All breeds so far analysed have been found to be based on a few pedigree breeders, about 20 in British Friesians, rather more in Dairy Shorthorns, rather fewer in Ayrshires and Aberdeen Angus. These men buy from each other or in the case of Friesians from Holland and elsewhere, but not from other members of the breed. Depending on them is a zone of breeders who buy almost entirely from the top few, below them is a zone which buys only from the second zone, then only from the third zone, and finally we have the non-pedigree breed members. This is a simplified and generalised description. Any member of zone may occasionally buy direct from the top few herds in practice. In dairy cattle which use A.I. this is always the case. The point is that a very few men determine the breeding policy of their herds, the rest buy from these key men and so multiply up the results of their efforts. The second zone, by buying continually from the top herds, will be where the top herds were two or three generations back, the next zone will be catching up, too, but a little behind, and finally the non-pedigree animals will be catching up, but at the tail of the procession. The genetic distance separating the top from the bottom is about 6 to 8 generations in most breeds. It is obvious that the common breed structure is an exceedingly efficient one for spreading the work of a few men to the breed as a whole.

The actual genetic differences between the top and bottom of the breed will be determined by the rate of change in the top few studs. If these are static, in the course of 8 generations the non-pedigree animals will have caught up to them and there will be no genetic difference between the top and bottom of the breed. Such an analysis has been carried out in British dairy cattle. It was found that not more than 10 per cent. of differences in mean performance of herds was genetic. The maximum genetic difference between top and bottom of a breed was 100 gallons a lactation. Actual differences of 1,000 gallons were recorded, i.e., top Friesian herds averaged 1,500 gallons, bottom Friesian herds averaged 500; of the 1,000 gallon difference at least

900 on average could be attributed to feeding and management.

The commercial breeder can use such an analysis in two ways. He can tell from it whether he should turn first to breeding or to management when trying to improve the performance of his animals. He can also say to what extent it will pay him to change the source of his sires. If the genetic spread between zones is small there is little to choose between them from his point of view. But if it is large it may pay him to buy a stud animal occasionally from one of the top studs. But he should remember that performance alone will not tell him what the genetic spread is. The total difference must be split into its two components.

Some breeds are divided into sub-breeds which have become partly separated and specialised for different roles. In England the Shorthorn herd book makes no distinction between dairy and beef shorthorns, although these two subdivisions have not interchanged genes for several generations. The Merino breed is divided into fine, strong and medium subdivisions and is quite likely still further subdivided owing to the size of studs, which has allowed the master studs to close their flocks to all outside blood. This does not alter the zoning effect which applies to these sub-units just as though they were breeds. But if the subdivisions are selected on different lines, a genetic difference will be introduced at all levels. It is not clear as yet just how much genetic difference there is between beef and dairy Shorthorns, or the different sub-groups of Merinos. That there is some is obvious. It will be found in general that average differences between breeds and sub-breeds are far more likely to be genetic than differences between zones of the same group.

Recent work in quantitative genetics provides the master studs with a method of deciding between possible breeding programmes for characters of performance. It does not aim to cope with those characters, such as resistance to fleece rot, which are only occasionally of importance when the unfavourable seasons come round. Such characters must be watched for by the experienced stud master or become the subject of special study. It provides the commercial breeder with a method of choosing between possible policies when trying to improve the performance of his animals and when buying stock. Its effects are therefore largely on policy and of a long-term character. In any event the unit of time during which changes can take place through breeding is a generation so that too much must not be expected from breeding schemes. At the same time an increase in egg yield of nearly 100 per cent. in 12 years brought about by Dr. I. M. Lerner should be dramatic enough to convince anyone of the efficiency of scientific animal breeding.

References

Lerner, I. M. (1950).—Population genetics and animal improvement. Cambridge University Press.

Mather, K. and Harrison, B. J. (1949).—The manifold effect of selection. Heredity Vol. 3. Parts 1 and 2.

Robertson, F. W. and Reeve, E. C. R. (1950).—Studies in quantitative inheritance.—I—*J. Genet.*, **50**: 414

Robertson, A. and Rendel, J. M. (1950).—The use of progeny testing with artificial insemination in dairy cattle. *J. Genet.*, **50**: 21.

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AGRICULTURAL ENGINEERING

By G. H. VASEY

I.

WHAT DOES IT MEAN?

In the days when the agricultural colleges of the U.S.A. were like our agricultural colleges here in Australia—that is, about eighty years ago—the future farmers were given some instruction in farm mechanics. While lesson number one in say "Farm Practice" would be then, as it is here today, "how to harness a horse", so blacksmithing and shoemaking, and of course plough setting and the re-pointing of tools, would be part of the instruction in farm mechanics. The word mechanics was taken broadly enough to include how to build a silo, swing gates, and dig drains.

Mechanised agriculture and the Land Grant Colleges have come a long way since then. The growth of mechanised agriculture we have seen for ourselves, we have had a notable share in it. The growth of the Land Grant Colleges, and the measure of importance accorded to the mechanical side of agriculture may be conveyed by farm mechanics graduating to a variety of special studies called agricultural engineering.

Three Notions

Before saying what Agricultural Engineering is, it would perhaps be well to say what it is not: it is not Farm Mechanics, and it is not Farm Mechanisation. Let's get it straight.

Farm Mechanics is the mechanics, the adjustment and repair of implements; this implies and requires working at the bench, with the hands and with tools and machine tools. Farm Mechanics also includes pottering, perhaps successfully, even profitably, with "inventions" worked out on the basis of trial and error.

Farm Mechanisation is a farm management policy of doing the farm and field jobs by or with the aid of power and machinery; this means the proper selection of machinery and their power units, and their effective deployment and use. To understand farm mechanisation one needs to know the specific duties of machines as well as their capacities and performance. For this measure of understanding one does not require to be either a mechanic or a professional engineer; after all, a printer and publisher has to know his machines, but he does not need to be a mechanic to repair them, or an engineer to design and make them.

Agricultural Engineering on the other hand, is a method or system of thinking in terms of the physical forces of nature and their control and application to human needs, in this instance, the particular need of food production. Thinking in these terms is usually possible, or at any rate facile, only for those who have been trained as professional engineers, i.e., trained in the mathematical and physical sciences, and trained in the art of design, that is the art and science of synthesising physical materials into a workable whole that will meet the desired objective.

If agricultural engineering means anything, it means the application of this kind of thinking to the field-work of agri-

G. H. VASEY, B.C.E., is Senior Lecturer in Agricultural Engineering, University of Melbourne.

culture — the power, machinery and structures for dealing with soil, water, crops, animals, and for that matter with the farmer himself!

Farm mechanics has been a part, very nearly the whole, of the honourable trade of blacksmithing for a very long time. It has been taught, not so much as a trade but as an accomplishment, at agricultural colleges in most parts of the western world, and in more or less degree at our own colleges, our Dookies, Roseworthys, and the rest.

Farm Mechanisation

Farm mechanisation becomes a topic for discussion, and of study, wherever there is a choice of methods for a particular farm job. Though today there is less and less scope for a discussion on the lines "By hand? or by machine?" or "By horse? or by tractor?", nevertheless we have a choice, not only between machines of different type and size, but between different processes aimed at the same objective. So "Farm Mechanisation" is the disciplined sorting out of ideas about width, size, capacity (through-put), draught, speed, operation, maintenance and repair of field equipment for a particular job. "Particular" is important, because farmers firmly believe that each man's situation is unique, and so requires a technique or a machine "just a little different".

To make an intelligent appraisal of a machine's or a process's value to a farming enterprise, requires a very fair knowledge of what the machine is supposed to do, and of what in fact it does and does not do: and it requires some idea of how the machine does it.

It would be nice also to be able to decide, from inspection, how easy or hard it is to maintain the proposed machine, or to replace worn parts, or simply to make adjustments, or even to work it.

All this, with the accompanying estimating of power required, of time taken, of acres done per day, of labour disposal, is the field of farm mechanisation.

A Factory Business

The modern, i.e., the power farmer, is like the owner of a factory business, who knows what his products are to be, selects machines that purport to do what he wants, arranges them on the floor of his factory, and arranges his work schedules so that his machines and his men profitably convert raw stock into finished products.

Once the equipment has been chosen and bought, then the farm manager's job is something like that of the commander of a group of army vehicles in the field. There are the jobs to be done, here is the equipment; it is his job to use the equipment in the best way to achieve the objectives; this means training himself and his men in how to use it, and how to maintain it, for "daily maintenance" is the task of the immediate user.

So to cope with farm mechanisation one must also have some superficial understanding, some "know-how", of how machines work; in short, be a practical sort of man willing to drive the machines himself, and willing to crawl underneath if necessary.

Teaching Farm Mechanisation

And so at agricultural colleges and universities all over the mechanised world, they teach courses in mechanised agriculture to the future farmers and farm advisers. Such courses are rather like instruction given to troops in artillery, or radar, or armoured fighting vehicles, or in any mechanical or electrical equipment, i.e., an outline of policy and objectives, little theory, but much detailed description, and some or much "drill" or practice in examining equipment, taking it to pieces ("on the command 'One . . . '"), putting it together again, and going through the motions of working the machines as though in the field.

Text books for this sort of work cover description, operation and maintenance. The English texts emphasise description, performance and costs, and are really written for the farmer who wants to go mechanical. The American texts emphasise also the class jobs of dismantling, adjustment and maintenance. Some of these books almost reduce the work to a drill (not quite "on the command 'One . . .' "), and are intended as much for teachers in the high schools as for agricultural students in the colleges.

At the American Universities this material is taught in the presence of many samples of the equipment in the laboratories (apart from the working equipment on the college farm) ; there would be one of everything, and several tractors (given by the companies; and changed for new ones every few years!). In the universities and agricultural colleges in Great Britain, the university or college farm provides the demonstration equipment.

Engineering, on the Other Hand

But if all this makes up the notion of "Mechanised Agriculture" it is not what is meant by "Agricultural Engineering". At the risk of appearing more than usually dull to readers whose professional classifications are abundantly clear, and in spite of the definition or description given at the beginning, it might be necessary to explain "engineering" a little further, remembering in any event that we are thinking of the professional side of engineering.

Everyone no doubt has heard of civil engineering, mechanical engineering, more recently of chemical engineering; in some parts of the world, too, they speak of agricultural engineering. Although each of these describes a particular field of interest, it does not explain well enough the function that that kind of engineering, or an engineer of that kind, performs. Functional analysis suggests that there are two jobs specific to the field of engineering—design and management.

Engineering—The Science and Art of Design

By some, design is thought to be the real core and essence of engineering: it is the closest to basic science, being the application of science, i.e., knowledge of a special kind, to problems that might be described as mechanical (vis-à-vis biological).

Design is not only the application of science, it involves the notion of choice—several methods, different materials are available; rarely, if ever, is there only one possible answer to a design problem.

The fact that design involves choice—a series of choices—makes it something of an art; though the engineer rarely admits this, the architect likes to press the point that he is at heart an artist, though professionally a planner of homes.

As with any art, engineering design has its orthodoxies and its fashions: it is orthodox to weld, to use vee belt drives; it is the fashion to use plastics and die-casting, and to give things a smooth so-called "streamlined" appearance; though it is still the fashion to make agricultural machinery as though it were made by the blacksmith.

Designs change, and the designer escapes from routine because research is always presenting him with new materials and new processes. A new application of knowledge, a new choice made, is something the designer always hopes for—he calls it an invention.

Engineering—A Problem in Management

The designer's job ends on paper—a drawing and usually a specification. While the designer turns his mind to something else, the engineer in his second capacity—as manager of a factory, or a works, or a construction job—converts the design to a real physical object—built in accordance with the terms of the design, and of the decisions implied in the design. Decisions must still be made, but of a different kind—the day-to-day tech-

nical decisions of how to get the specified result.

Ultimately one graduates to the realm of "top-management", where one controls both designers and managers that make up the whole team of engineering. The board decides whether the road should go from A to B; the chief engineer decides which of two or three possible routes; the designer lays out the route in detail on the plans; the construction engineer gets the job done.

Engineering in Agriculture?

If this, at length, is the meaning of engineering, has any of it any place in the field work of agriculture?

Obviously implements must be designed before they are made, or copied. To satisfy the designer and the user there must be continual research into materials and methods of using them, and continual research into the basic science of the soil, and crop material and water that are to be handled by the machines.

Then there is our continual attempt to adjust and control the surface of the soil, and its moisture; here there is scope for the techniques of the engineer-manager—the field engineer—as well as for basic research into the soil-water relationships and methods of controlling them.

Mechanised farming is a business like a factory, though the machines are usually taken to the work, instead of the work to the machines; it requires much the same sort of management as a factory, especially the under-cover jobs. So the field work of farming could gain from the study of management techniques, of unit processes, of machine performance, and even of work simplification. The housing and planning of the under-cover jobs deserve, as part of the business, as much care in design as the planning and layout of any other factory or reproductive building.

There is obviously scope for the engineering approach, i.e., in management, design and research, in much of the field work of modern agriculture. And the fact is that a lot of engineering work has been put into the industry, whether we recognise it or not. In Australia, agricultural engineering is not recognised; that is, it is not recognised in the universities as a significant branch of study; it is not recognised by professional engineers as a part of their profession; and it is not recognised by higher agricultural authority as a proper field for research or extension. In this lack of recognition, or should we say delay in recognition by fifty years or so, we differ from the other modern agricultural countries of the world.

II.

WHAT OTHERS THINK OF IT

(a) UNITED STATES OF AMERICA

By the end of last century departments of agronomy in several of the Land-Grant Colleges were adding to themselves sections in farm mechanics, with field equipment, and floor space for displaying it, and workshops for smithing, fitting, and the like. At Kansas State College in 1904, these activities blossomed into a full department of agricultural engineering with a degree course, professors and all. Along similar lines the University of Nebraska, and Iowa State College, soon followed. In 1907, a meeting of teachers from various institutions began in a small way what has become the American

Society of Agricultural Engineers, a professional society, smaller than but comparable in purpose to the big affairs like the American Society of Mechanical (or of Civil) Engineers.

Agricultural Engineering—Full Blown

So today in most of these Colleges there is a separate department of agricultural engineering; some, that do not offer degree courses in agricultural engineering, are attached to the college of agriculture; but those that do offer such degree courses are a department of engineering, comparable to civil, electrical, or mechanical. Naturally both faculties of engineering and agriculture have a finger in the pie of these departments' policies and courses; nevertheless agricultural engineering is generally accepted on these campuses and in professional circles as a branch of engineering in its own right.

Teaching

The activities in these departments, as all through these Colleges, are threefold: Teaching, Research and Extension. Teaching is at three levels: farm mechanics and farm mechanisation to students of agriculture, and professional engineering courses to students of agricultural engineering.

Of the four years in the degree course in agricultural engineering, years one and two and parts of three would be identical with other engineering curricula; the introduction to agricultural science and the specialisation in professional engineering come in third and fourth years.

All the activities in these departments of agricultural engineering, i.e., the teaching, the research, and the extension, are by common consent grouped into four fields of interest: Power and Machinery—as you would expect; Farm Electrification; Soil and Water, i.e., water supply, soil conservation, irrigation and drainage; and Structures—farm buildings of all kinds, including the farm home, and such simple things as fences.

We must postpone for the time being any discussion about the B.S. degree courses in engineering and in agricultural engineering, being content to note that, though first degree courses in agricultural engineering are encouraged by the profession, they are not found in all the agricultural colleges. Cornell University, for example, the Land Grant College of New York State, has a department of agricultural engineering, which conducts research, takes candidates for higher degrees, and provides extension officers; but it does not provide undergraduate courses in agricultural engineering.

Research

Not only do the American colleges and universities turn out large numbers of graduates having their first degree—the B.S. for example—they also encourage research and higher degrees, and provide for both in their graduate schools. This is true for all branches of study from atomic physics to the study of janitor services in schools; it is true also for agricultural and other branches of engineering. Students, having taken their first degree, are encouraged to come back for post-graduate studies; this means doing more formal courses, even for the Ph.D. degree, and carrying out some work of investigation and writing a report. Since about ten per cent. of graduates return for post-graduate work, and since the large staffs in the departments are expected to take their share of research work, the amount of research of various kinds and qualities done in the colleges in agricultural engineering adds up to a good deal.

Machines

Research of this kind may or may not be in fundamental science, but it does have an effect on the makers of machinery and equipment, and on farm practice. For example enquiries and tests by F. W. Duffee at Madison, Wisconsin, on forage harvesters in the 1920's, exposed weak-

nesses in design and performance; the makers saw the point, and set about improving them. In this way practically all farm machines and equipment have been subject to field testing, at one or other of the colleges, though this field testing is done in an *ad hoc* rather than a formal way, and essentially in the course of college researches. Usually, if a firm wanted to submit its machine for the college blessing or approval, the college would not take it, unless there happened to be a current programme for studying machines of this type.

On the other hand a college, in its department of agricultural engineering, might well find it necessary to design new implements for its own use—they may or may not be taken up by industry, e.g., various oddities at Ames (Iowa State College). Or they might find it convenient to accept a request from industry to design a particular machine, e.g., at Davis, California—the walnut cracker, and the lemon sorter that sorts on the colour of the lemon.

Meanwhile there are experiments on the use of electricity, e.g., heating and sterilising in various forms—infra-red heating of pig farrowing pens, ultra-violet lures for corn borer moths, domestic heating and cooling, including the heat pump using the soil as the source of low-grade heat.

Soil and Water: Structures

There is continual work on the techniques of farm practices aimed at the control of soil and water, as well as investigations into problems of irrigation and drainage. A tremendous effort is put into irrigation studies at places like Davis, California, and at other centres in the Pacific and Western States. Specific problems of run-off, erosion and conservation are also studied at field stations by the Soil Conservation Service, an agency of USDA.

So too with *farm structures*—enquiries into use of materials and methods of construction, into problems of heat, cold and humidity; into fire hazards; and into designs and plans for specific purposes, even into such apparently simple things as feed racks and bunks for the feed yard; and the whole problem of conditioning and storing of grain and fodder. One wants to remember that the tradition, both European and American, is to take farm buildings seriously; after all, their winter is much worse than ours, and their animals in the north are housed for four months of the year. Even so it is interesting to note that the animal housing policy, or at any rate the degree of housing, is itself coming into question, leading, for example, to studies like the steel barn project at Madison, Wisconsin.

Barn Chores

There are two lines of research going on today which I think are most important; first, into mechanical or even automatic methods of preparing animal food, and feeding it to the animals in the barns. Everybody with animals will have grinding mills and conveyors and storages, but on the whole the individual parts are not integrated into a composite whole. Although they are worked by electricity they require constant attention and manual control. Even when the food is prepared and stored it is usually conveyed to the stock by hand barrows or other relatively crude methods. Not always, of course—but the need to study ways of simplifying this work is now receiving attention in one or two quarters.

The other significant problem that is coming in for a little attention is the whole question of economy of human effort and time in farm chores, particularly the barn chores. Economy is the point, and the work began with the economists who were concerned with farm management surveys and studies—men like Engene at St. Paul (Minnesota), Hardin at Purdue (Indiana), and Brunk at Cornell.

The mechanical engineers have been at this for a long time in industry, but the

agricultural engineers are only now waking up to their opportunity; men like Cleaver at the University of Illinois are studying milking sheds and milking routines. The simplest survey of farm routines will show how badly organised and unthought are many or most of the routines, especially those associated with animals.

Effect on Agriculture

So the colleges affect the design and manufacture of machinery and equipment of all kinds indirectly: (a) through these investigations and the published papers; (b) through the graduates, a proportion of whom get jobs in the firms; and (c) through the extension officers who carry the latest technical news to the farmers themselves; such news creates a demand for good goods.

In the same way the standard of farm life and farm work in all its mechanical aspects is continually being jogged, helped and improved by the fact that at the College, only a few miles away, or at the other end of the telephone, these expert jobs are going on, and by the further important fact that there are special officers to carry the information, either hot news or common sense, to the men in the field.

USDA Research

In addition to the college staffs and post-graduates, research is also carried out by the U.S. Department of Agriculture itself, both by officers located at the colleges and working with the college teams, and by researches conducted at its own experimental headquarters at Beltsville near Washington, and at field stations of the Soil Conservation Service.

USDA also runs a special station at Auburn, Alabama, the U.S. Tillage Machinery Laboratory, that concerns itself with studies on the forces in implements and their behaviour, and the performance of tractors and tractor tyres. It is grandly equipped with long bins of selected soils whose moisture content and tilth can be controlled. Over these bins can be run a great carriage containing the test tractor or implement, and the measuring and recording gear: a most expensive setup that might well have rendered futile all other attempts to study similar problems.

Nebraska Tractor Tests

We will have gathered that it is not the practice for the colleges either to test machinery, particularly on behalf of the makers, or to test particularly on behalf of the users; enquiries in the interests of pure science, it is supposed, serve the interests of both parties. There is one important exception, and that is the testing of tractors in the department of agricultural engineering at the University of Nebraska.

It appears that after the first World War, tractors began to boom; but they also bust, and fell so far short of the claims made for them, that the country party in the legislature of the state of Nebraska could not stomach this racket, and passed, in 1919, the famous law that said: no tractor may be sold in this State unless a prototype has been tested at the University, and a certificate issued by the Railway Commissioners. Although enacted only in Nebraska the law had the ingenious effect of covering the whole of the country. The law, of course, had the desired result, and no one doubts its basic value; the tests are very widely known, and have played their part in raising the status of tractor design and building. I personally attended test No. 465; by now the score must be nearly at 500.

Extension

All readers of this Journal will know of the widespread system of agricultural extension in the U.S.A., a system that is rooted in the Land-Grant Colleges, and that reaches through the local county agent to every agricultural county in the land. The point here is that among the

extension specialists centred at each college are four groups of agricultural engineers, covering the fields of structures, soil and water, power and machinery, and electrification. These officers, graduates in agricultural engineering, are, of course, further supported by daily contact with the teaching and research activities, and by a great quantity of extension type literature that presents in easily readable form the research findings appropriate to the local countryside. In this way the individual farmer, large or small, is never far away from specialist technical advice or instruction, not only on his biological and cultural problems, but on his mechanical problems as well.

An Organised Whole

So it is that, except for the making and selling of agricultural machinery and equipment, all the processes in agricultural engineering—college teaching, research and extension—are completely covered, and simply organised and smoothly run, through the system of state colleges and universities, with various measures of finance and co-ordination and co-operation from the USDA.

A remarkable notion indeed in a country which is supposed to be mainly industrial, and a country which prides itself on being—and of course is—the very ark of the covenant of private enterprise. The system is so completely accepted that it has the support of private enterprise in gifts of both finance and equipment. For example, the tractors and harvesters and other equipment used for teaching and research in the Colleges are never bought —they are lent by the firms, and kept new by being replaced every two or three years.

The point is that the Americans have recognised that "agricultural engineering" is a wider term than power and machinery, tractors and ploughs; and much wider than setting a plough or adjusting a mower or a thrasher drum. It is also tidily organised through the state colleges and their departments. It is also clearly understood by all concerned that, though agricultural engineering is accepted as a branch of professional engineering, that branch is also rooted in agriculture. If there is to be teaching or research in this field, then that teaching and research must not be isolated or *in vacuo,* but can only be successful in institutions, such as the Land-Grant Colleges, where both agriculture and engineering are taught and practised.

(b) GREAT BRITAIN

The National Institute of Agricultural Engineering

British agriculture successfully resisted the intrusion of professional engineering and engineering research until the last war. True, there was the Institute of Agricultural Engineering at Oxford from the first war; it ran a few tractor trials and wrote a few papers, but made no significant impact on either British agriculture or the implement and tractor industry.

During the second war the changes in British agriculture were so startling (not only an increase in cropping as against grazing, but a desperate need to convert to mechanical methods in the field) that the Institute sprang to life and usefulness. It was shifted to Askham Bryan in Yorkshire, and taken under the wing of the Ministry of Agriculture and Fisheries. There its task was largely the testing of machinery and tractors to help decide whether steel should be allocated to particular firms making particular implements: if the implements were not good enough, no steel. The Institute was also involved in running a training centre for sending out the large number of machinery advisory officers required to help farmers in the food production drive.

After the war, the Institute moved to its present home, at Wrest Park, Silsoe,

Bedfordshire, under the wing of the Agricultural Research Council, and carried with it three things:—a wealth of competence and experience in its staff, which now numbers about 300, of which about 100 are qualified engineers and other scientists; a great deal of prestige among both farmers and machinery firms arising from the quality of its work during the war; and a useful residue of power arising from its prestige.

NAIE Policy

The Institute's attitude and policy strictly conform to the notions of free enterprise: it will help the farmers get good machines by helping the firms to design and make good machines and tractors. The Institute's reputation, built up under the pressure of steel allocations, now ensures that a firm offering a machine must virtually seek the Institute's blessing for it by having it tested. If the test is unsatisfactory the firm will have no report to flourish in its favour; what usually happens is that the Institute helps the firm with advice or further experimental work, aimed at making a better machine, if the Institute thinks the original worth the trouble. The Institute will only publish a report with the concurrence of the firm; consequently, you do not see the critical reports. At the same time the Institute has control of what the firms quote from reports; and so the absence of a report is a disadvantage. So the Institute has tested and reported on a wide variety of implements and tractors and driers and sprayers.

NIAE Research

But formal testing is not its only occupation. Its engineers are willing to follow up a possible mechanical clue, and develop an idea into something that will work; the idea might be the firm's, or it might be the Institute's: the Institute has taken out several patents for improvements on existing machines or attachments to them.

The work goes even deeper than this development of an existing idea. You will find in odd corners the maddest ideas floating round—ideas that go with true research: for example, the hydraulic drive for tractor wheels, instead of the orthodox transmission; and a single wheel tester for the study of traction.

Studies of grain drying techniques are accompanied by fundamental studies of the physics of moisture in grain and individual grains, and its part removal.

Even tractor testing is not confined to the mere formal testing of production models in accordance with the British Standard test code; though the B.S. code, similar in most respects to the American standard used at Nebraska, differs from it in enough respects to make it a better test. The NIAE will conduct much fuller tests on prototypes, tests that include field trials on various classes of land. The Wrest Park team has continually tried to devise tests that will reveal the tractor's performance in the field as well as on the test track.

Apart from all this the tractor group has made a real study of tractor performance, particularly the effect of gears on fuel economy; it was this that led Hamblin to work on the hydraulic tractor drive. All this has produced a body of understanding of tractors and tractor performance that must be unique.

We do not need to suppose that all the science at Wrest Park is physics and mathematics, or all the workers engineers; far from it. The Director himself is an agronome, two of the sections are agricultural; and soil physics and statistics are part of the establishment. The NIAE is a team where each man not only works in the field where he was trained, but works with understanding with men trained in a different way; but all aimed at better agriculture through engineering.

It is true, the NIAE, which is entirely a research organisation, confines itself to

power and machinery and allied problems like the heating and drying of grains and other plant material. For research on the mechanics and physics of dairying one must go to the National Institute for Research in Dairying near Reading. Research in the applications of electricity to agriculture is in the hands of the British Electrical and Allied Industries Association, which conducts a small station, also near Reading.

In inheriting its farm buildings from the last hundred, two hundred, or even three hundred years, British agriculture has inherited a most difficult problem: how to adapt old buildings, some of which look more like seminaries and colleges, to modern agricultural production. What research there is into this urgent difficulty is being done at the Buiding Research Station of the D.S.I.R.

Teaching in Great Britain

There is one degree course in agricultural engineering, notable for its being recommended by the Loveday Committee on Higher Agricultural Education, for its being only three or four years old, for its being not an undergraduate course but a post-graduate course on top of engineering or agriculture, and for its being located not at Cambridge or otherwise near Wrest Park, but at King's College, Newcastle-on-Tyne. Wisely the Loveday Committee recommended that any such courses or university departments should be placed where there are faculties of both engineering and agriculture; this is true of Newcastle.

At the Schools of Agriculture in the other universities (e.g., Cambridge, Nottingham, Edinburgh, Reading) the agricultural students are exposed to courses in farm mechanisation; while at the Royal Agricultural College at Cirencester the courses are in farm mechanics, building construction and surveying.

Only King's College, Newcastle, offers engineering training in its applications to agriculture at professional level; even there the emphasis is on power and machinery, with little reference to structures, or to soil and water problems. Naturally some research is done at King's College, Newcastle, in power and machinery, to keep the teaching vigorous. The barn chores have been studied by the agricultural economists at Cambridge; the soil physicists at Cambridge, too, have an elaborate set-up for fundamental studies of drainage. But it is clear that the contribution of the universities to agricultural engineering in Great Britain is relatively small.

Extension in England

In comparison with the simple county system for all agricultural extension in the U.S.A., the position of engineering advisory services in England is complicated. For advice on power and machinery the farmer goes to the local Machinery Advisory Officer of the National Agricultural Advisory Service; he is not an engineer but a diplomate in agriculture with further training in mechanisation; nevertheless such men can usually give the answers to questions of selection of equipment, and its adjustment and operation. For advice on farm buildings and drainage, and the physical structure of the farm, the owner of the land goes to the local officers of the Agricultural Land Service.

In Great Britain then, in comparison with the nicely tied up and complete system of the U.S.A., agricultural engineering research, teaching and extension are disorganised in typically British *ad hoc* fashion among all sorts of agencies; the term agricultural engineering, is for all practical purposes at the moment, confined to the notions of power and machinery.

(c) SWEDEN— FARM MECHANISATION

At Uppsala, in Sweden, there are two centres in this field. The *Institute of*

Agricultural Engineering is a teaching and research unit of the Royal Agricultural College of Sweden, at Uppsala (not part of the Royal University of Uppsala which is for general science). The emphasis here, in a variety of courses of varying length for different types of students, is in mechanisation, not in engineering (notwithstanding the Institute's title). The students who pass through it are students of agriculture, training as practical farmers, or advisory officers (including machinery advisers), or agricultural scientists—agronomes.

The Farm Machinery Testing Institute is heir to a keen interest by the farming community in agricultural machinery. The testing of machines and implements began at various teaching centres in 1897; the present organisation was set up in 1930; since then it has carried out about 1,000 tests. The tests are of two types: (a) formal tests on marketed machines; although these tests are voluntary by law, they are now virtually obligatory by custom; the results are published; (b) confidential tests for makers, on trial machines; the results of these are not published. There are two points of special interest: tests include practical use in the field by co-operating farmers; and there are 20,000 subscribers to the test reports, and 370,000 subscribers to a monthly bulletin containing summaries of the current reports.

Although this activity is largely financed by the government, with some return from nominal test fees, it is obviously supported by a large measure of interest from the farmers themselves.

The agricultural advisory or extension service works through the district Royal Agricultural Societies; each centre will have a machinery adviser who has been trained in farm mechanisation at the Institute for Agricultural Engineering.

So it appears that, in some parts of the world (it is true also of the U.S.S.R., Germany, Belgium and Italy, and such world organisations as F.A.O.), engineering—professional as well as "mere mechanical"—has made and continues to make useful contributions to the field work of agriculture. What is more, these contributions are recognised and accepted by farmers, agricultural scientists, and administrators. We in Australia can consider ourselves fortunate—or backward, depending on our point of view—that we have so far got by without any such professional help, in either teaching, research, or extension.

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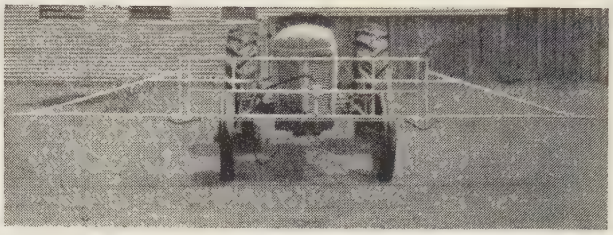

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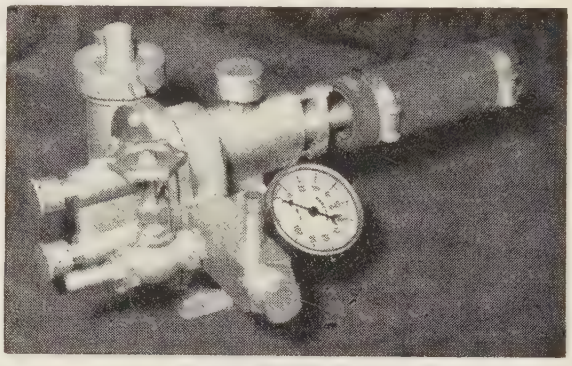

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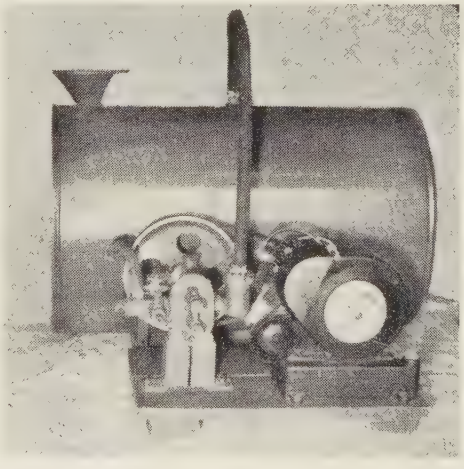

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SOME OBSERVATIONS ON THE VEGETABLE INDUSTRY IN AUSTRALIA

By G. C. HANNA

Introduction

I have had a most unique experience studying Australian vegetable production in all of the principal areas of Australia with the exception of the west. This was made possible through the co-operation of a number of canners and the state departments of agriculture of New South Wales, Queensland, South Australia, Tasmania and Victoria. I would like to take this opportunity to express my gratitude to all of the men and organizations for the numerous courtesies extended to me which made my visit to Australia a most delightful one. Space and ability on my part do not permit me to do justice to this subject. One simply cannot say enough about Australian hospitality.

The purpose of my visit was to study vegetable production methods and then point out how production could be increased and production cost reduced. Unfortunately anyone making such a study is a victim of his past experiences. It is almost impossible to lay aside these experiences and objectively study the situation at hand based on its own merits. Since most of my experiences have been with large-scale operations relatively well mechanized, I found it most difficult to study without prejudice the relatively unmechanized small-size farms found in Australia. It is essential for the reader to keep this in mind in appraising what I have to say. I ask the reader to remember that it is a part of my job to criticize, to point out any weakness or inefficiency that I found anywhere. These criticisms bear no malice but are made with the hope that they may be of some benefit to Australia. It is easy to make destructive criticism because it is easy to see when something is not working as it should be. It is difficult to make sound and unbiased constructive criticism even with considerable study and research on all of the interrelated problems. Nevertheless I have offered some suggestions for your consideration at the end of this paper.

Professor G. C. HANNA is Olericulturist in the University of California, Davis, California.

Price levels

Early in the study of this problem it became apparent that regardless of the very high prices obtained Australia was not getting sufficient production to meet the demand of the canners. By very high prices I mean compared to Californian prices; these have encouraged the growers there to increase production. In general, the Australian canner pays two to three hundred per cent. more for vegetables than the Californian canner. Let us make a specific comparison. By adjusting the United States and Australian weights of a ton and using a four-dollar pound, which I understand is approximately correct based upon the actual cost of living, the Californian canners paid tomato growers £6/12/- per ton* in 1950, and the growers planted 76,000 ac. In 1951, the price was raised to £8/9/- and plantings were raised to 148,000 ac. The growers realized at planting that there was likely to be a huge deficit in labour supply due to the increase in acreage plus the large expansion of cotton acreage, which competes with tomatoes for labour. Yet the increase from £6/12/- to £8/9/- was a sufficient inducement for them to take the risk. The 1952 price

*The price paid to Californian growers in 1950 was $25.00 per ton, and $30.00 per ton in 1951.

has been reduced to £7 per ton to curtail production, and Californian plantings have been reduced to about 115,000 ac.

Reasons for these price levels

The big question is why has an an increase up to a price of £8/9/- in the United States resulted in a glutted market, and an increase ranging from £17 to £19 in Australia resulted in a deficit? Several factors could affect this condition. They are: yield per acre, cost of production, labour supply, competing crops, availability of suitable land, transportation, growing and harvesting hazards, income tax and the social position of a tomato grower.

Yields per acre

The average yield per acre in California from 1940-1949 was 7.8 tons, and in 1951 it was 14.9 tons. Comparative data for Australia were not available to me, but in talking with canners and growers I gathered that per-acre yields are equivalent to those for the United States or higher. Therefore, yield per acre does not contribute to the price differential.

Growing and harvesting costs

The cost of production is difficult to compare because of lack of available data. Picking cost per ton is approximately the same in both countries. Therefore, any material difference would be due to pre-harvest costs. Since the degree of mechanization is relatively low in Australia, the pre-harvest cost must be considerably higher than in the United States. The main difference appears to be due to the greater man-hours required in Australia, where I was informed several times that it requires one man practically full time to care for one acre of tomatoes. In California, after transplanting, or after thinning in the case of direct seeding, one man is expected to care for 50 to 60 acres up to harvest. Proper land levelling and mechanization are the principal reasons for the difference in acreage that one man can handle.

Availability of labour

Available labour for harvesting is a serious problem in Australia as well as in California. A major portion of the tomatoes grown in Australia are harvested by the grower and his family, or sometimes by one or two helpers. In California on the other hand practically none of the harvesting is done by the grower or his family, and he must depend upon hired labour. It has been necessary to provide housing facilities with sufficient amenities to attract labour. Thus they are able to compete successfully with the secondary industries in the labour market. It appears to me that this is a lesson the vegetable industry in Australia must learn.

Availability of land

The supply of good land in Australia suitable for tomatoes that can be irrigated is not very plentiful under present conditions. Considerable areas of marginal or sub-marginal land are in this category only because of water and root penetration. Much of this land could probably be raised by research and an educational programme from the present yielding levels to a satisfactory level. Furthermore much of the present marginal land would give sufficient yields if the cost of production could be lowered.

Transport difficulties

Transportation is a serious problem. Even at a casual glance the inadequacy of the antiquated railroad system is obvious to anyone. The highways have not been built to withstand heavy trucking, but at present there appears to be no alternative. Although inadequate to give good service, they are remarkable when one considers the number of miles it takes to serve such thinly populated areas. It is a tribute to agriculture in Australia that it has progressed as far as it has with such poor transportation. One cannot blame either grower or canner for not venturing into the realm of perish-

able crops since adequate rapid transportation is not available.

Competition of other crops

There are several reasons why one crop may compete with another: greater returns per acre, less labour involved, fewer growing and harvesting hazards, more available machinery, greater knowledge of crop and less capital invested. By changing the relationship of any of the above items, competition may be either increased or decreased. For instance, mechanization of one crop may make it a more serious competitor of an unmechanized one. Development of better varieties often reduces the competition of another crop. Development of adequate pest control programmes may reduce the production hazards. More research on production problems usually results in increased yields and lower production costs. Research attention focussed on a crop rarely fails to improve production and there is always room for improvement. We admit this even in California.

Social status of the vegetable grower

The social status of the tomato grower as well as other vegetable growers in Australia is, to say the least, at an undesirable level. A large portion of the tomato production is in the hands of immigrants of the peasant class from Europe. Their past experience has been peasant agriculture, which has been imported with them. While peasant agriculture may be suitable for European conditions—although I would question this—it does not appear to be the best for Australia. Progress in industry is going forward at a rapid pace all over the world. Labour-saving machinery is the keynote of progress in today's mechanized world. Why should vegetable production remain in a relatively primitive stage? I do not mean to imply that the Australian is a poor vegetable grower. In many cases he is getting a remarkable yield per acre. His production per man hour of labour with the present methods is just too low.

Many phases of the vegetable industry in Australia reminded me of Californian vegetable production when it was in its infancy thirty years ago. At that time it was largely in the hands of peasant-type farmers from Europe and the Orient. This type of agriculture did not fit Californian conditions either. Fortunately the fruit grower was of a better class, and his success pointed the way for the vegetable grower. A vigorous campaign of a research and educational programme coupled with an increased demand for vegetables resulted in a drastically changed picture. Today, the vegetable grower in California is a very keen business man, whose business is vegetable production. Gone is the plough-horse because he cost too much and could not get the job done on time. Gone is the poor manager because he could not stand the keen competition. Gone, except in market gardens, is the small-sized farm because it cost too much to mechanize. The survivor demands constant research on fertilization, irrigation, soil management, pest control, transportation handling and labour-saving machinery, whereby he can reduce the cost of production. There are small farms in California, but the small farmers are not the leaders. They manage to eke out a living because the more progressive men have developed the markets and transportation. They merely hang on to the coat tails of the leaders.

Psychological reasons

The above are some of the physical reasons, as I see it, why cost of production in California is lower than in Australia. Besides these physical aspects there are psychological reasons. It appears to be a national trait for Australians to apologize for Australia and Australians. The usual excuse offered was that the nation is too young and the population too small to do more. If age and population were a criterion of progress, India and China should be the outstanding nations of the world. Who ever heard of a United States citizen apologiz-

ing for his country, or more particularly a Texan or a Californian apologizing for his native state? The thought would never occur to either that he had any reason for apologizing. On the other hand his supply of ego is largely responsible for spurring him on to do "what can't be done". A large number of growers in California have machine shops where they build or redesign tools when a suitable one cannot be purchased to fit the particular job of the grower. They take great pride in the development of machinery that "works". The influence of this pride of achievement is enormous in the mechanization of the agricultural industry. I found very little evidence of any such movement in Australia. It seems very strange to a visitor in a land where food production is in such demand to see instead so much interest in sports, race horses, the longest bar in the world, and the "six o'clock swill", all of which contribute little to the national welfare. This comparison does not imply that the Australian on the land lacks ability. Agriculture has largely been pastoral in Australia, resulting in a life of relative leisure. It has not been necessary in the past to face keen competition where the competent man has had to demonstrate his ability.

Closer settlement schemes

It might appear from the foregoing statements that I am placing all of the blame on the grower for high prices and low volume of vegetables. Actually, I think very little blame rests on his shoulders. How can one blame a peasant for thinking in terms of peasantry? Not all of the vegetable growers are immigrants from Europe. Some of them are returned soldiers that have been placed on an undersized block of land. The size of the "living area" has been pre-determined by some expert—or should I say pseudo-expert?—at government level. We also have these pseudo-experts in the United States. Are these returned soldiers not being forced into peasantry by regulations of the so-called "living area"? Should one determine a man's limits of production by determining the amount of land that he should farm? I raised this question with some of the field officers in charge of these re-settlement areas. They pointed out that a man may acquire other blocks in the name of his wife or children. Should the size of a man's family be a criterion of the size of farm he can manage, or should his innate ability be the deciding factor? I was on a number of farms where there was substantial evidence that the grower was a good manager. In most of the cases this grower himself was busy harvesting the crop. I also visited many farms where the evidence indicated that the grower was a poor manager. For the welfare of these men as well as for the nation, would it not be much better for the good manager to expand his acreage and hire the poor manager to do his labour? A good business man never types his own letters. Neither should an efficient man on the land take time to hoe or pick his own tomatoes. The essentials of good business are the same regardless of the enterprise, be it either manufacturing automobiles or farming.

In one area I found that not only the size of the block was pre-determined, but a part of the block was planted to certain varieties of apples with a definite percentage of each variety decided on before it was turned over to the settler. Now there is no question in my mind about the choice of varieties or the percentage of each variety planted or the ability of the man actively in charge of this programme. The question I raise is can you develop a virile grower who can depend upon his own ability by doing his thinking for him? Would it not be better to educate him so that he can make his own decisions? Is not education a more desirable method than regimentation in the development of an industry? I do

not mean to imply that the United States has solved all her agricultural problems, that all of the farmers do their own thinking, or that we are free of regimentation. This would be far from the truth. Regimentation has grown at a rapid pace during the past two decades. Fortunately there is some evidence of a strong movement to halt this danger.

I was in another re-settlement area that was to be devoted to citrus production. During the interim between planting and bearing, some of the land between trees was planted in vegetables. Much to my surprise some of the officers in charge of certain aspects of this programme were trying to discourage vegetable production. Upon being questioned as to the reason for this, they explained that the growers might want to continue to grow vegetables rather than citrus. I question the ability of anyone, regardless of who he is, to pre-determine what is to be grown in an area to produce the most food. The "Five Year Plans" of Russia were failures. Judging from the decline in production of food in Australia I would say that the various commodity boards, such as the Potato Board, Wheat Board, etc., are also failures. Dismal failures. Why do I make this statement? Simply because instead of production being controlled and stimulated up to a point, it is dropping. There seem to be boards for everything except building houses. Australia is noted for its wool and beef production. I understand that neither of these commodities has ever been subjected to governmental regimentation. As yet there is no formula for a suitable substitute to "the Law of Supply and Demand". Australia as well as the United States should learn that "little men in high places" are dangerous.

Defeatism

As I travelled about Australia, talking with growers, canners and business men, I found most of them agreeing with my point of view. They agreed, but in almost the same breath most of them asked, "But what can I do about it?" Whenever I offered a suggestion as to what might be tried it was usually met with a number of apparently good reasons as to why it couldn't be done. I found this "defeatism" quite depressing. It is vastly different from the cocksure attitude of the Californian that "We'll do it somehow"—and he usually does it. The "We'll do it somehow" attitude breeds success whereas the "but what can I do about it?" attitude will breed only defeat. Fortunately I found some serious thinking men who said, "We must do something about it". Australia needs more of these men.

While there are some grave physical handicaps to production, such as lack of suitable programmes of soil management, pest control, adaptable varieties, methods of transportation, etc., the greatest drawback is the mental attitude toward production. Given the proper viewpoint, with research and extension, Australia could practically eliminate many of the present physical handicaps or at least reduce them to a minor role.

Research and extension

I have mentioned several times the need for research and extension in Australia. This does not mean that neither is found there. On the contrary, I found considerable research at basic level. Most of this work is being conducted by the C.S.I.R.O. In my humble opinion they are doing some very outstanding work, work of which Australia can well be proud. Unfortunately the result of their work is not being used as it should be by agriculture because it is not being adequately presented to agriculture. Publication of the results of research in some learned journal in technical terms, or even in every-day language in a farm journal, is not adequate. Furthermore, occasional farm visits by the researcher will not adequately acquaint him with the problems of agriculture. Many basic research men in any country know so little

about agriculture that they would not recognise a field problem if they met it face to face. In other words a liaison is needed between research and agriculture. The realization of this need in the United States has led to the development of our Agricultural Extension Service. The function of this agency in the United States is limited strictly to an educational programme, whereby the results of research are taken to all the various phases of agriculture, and the problems of all phases of agriculture are presented to the research agencies. The success of this programme on the land is largely responsible for helping the grower analyze his problems and demonstrating methods that will correct the problems rather than the "do this and don't do that" type of programme. The extension service, through its constant contact with agriculture, has focussed attention on the need for research on agricultural problems. The solving of these problems has given agriculture confidence in research which in turn has made facilities available for more research. It is difficult to overemphasize the stimulating effect of the association of agriculture and research brought about by the Agricultural Extension Service. It has brought to light many problems of which neither the grower nor the research man realized the existence. To show how this works let me quote from a bulletin from the Tomato Growers' Association of the California Farm Bureau dated July 8, 1952. "Machines are expected to replace 1,500,000 United States farm workers by 1960. This is a drop of 17 per cent. The perfecting of a tomato harvester, or harvesters, is essential if the tomato industry is to keep in line with the rest of agriculture who have found methods by which they can replace hand labour through the use of mechanical harvesters." Thus progress in one phase of agriculture creates problems in another. Very few people ten years ago realized the need for a mechanical harvester for tomatoes. Research men should have realized this need many years ago because it is in line with the trend of mechanization on the farm. They should have been working on this problem in order to be ready for it when the problem arose.

It appears to me that agricultural extension in Australia is far behind research. This is no reflection on the men doing the extension work. The fault, as I see it, is due to lack of funds and personnel to carry on the work adequately. Most of the extension work is directed to the re-settlement areas, and outside of these areas and around the large cities extension practically doesn't exist as far as vegetable production is concerned. Most of the time of these men is devoted to regulatory work. They simply don't have time to devote to the educational phases. It is difficult for a man to gain the confidence of a grower if he is a counsellor one moment and a policeman the next. It was all too evident that there is a great need for a mutual and sympathetic understanding of the agricultural problems between research on one hand and the grower, shipper and canner on the other. Most of the practical research at the farm level is carried on by the men doing the extension work. I think this is a very good thing for Australia at the present time. This phase of research is woefully inadequate, due to the small personnel and lack of funds.

Marketing

I spent some time visiting vegetable markets and production areas for the fresh market. Chaos is the ruler of this phase of the industry. This is usually the case in any fresh-produce market. The thing that amazes me most is the very high price at which many of the vegetables are held in an over-supplied market. I was in Adelaide in February where snap beans were selling at 1/6 per pound; yet growers were taking beans back home from the wholesale market because there was no demand. They were also taking carrots home because there was no mar-

ket at 8/-. I was informed that growers a short time before, had refused to bring in lettuce at 5/- a dozen. This, transferred to Californian terms, is equivalent to $6.00 a crate, which is the price the lettuce growers dream about, though seldom enjoy. Out of this $6.00 price the Californian grower has to pay a packing charge of $1.50, which the Australian grower does not have. Why is such a marginal price to an Australian grower a boom price to the Californian? The answer appears to be the difference between large and small scale growers. In California the emphasis is on large scale production, mechanization to cut cost of production, movement of large volume, and low profits per unit—in other words "more and better for less and less". The Australian grower on the other hand farms on a very small scale. He is unable to mechanize because of the high overhead cost per unit on low volume. He must get a high price per unit in order to make a living.

Another item that adds to the high cost to the consumer of fresh vegetables is the method of distribution. A large portion of the vegetables are sold to the consumer by hawkers who peddle vegetables from door to door in the residential areas. They must make a high profit per unit to compensate for the low sales per day by this method of distribution.

I visited a farmers' market where the farmer brings his own vegetables and sells directly to the consumer. Here again inefficiency reigned. The result was a large number of salesmen trying to sell a small volume of produce, in which case the profit per unit must be high. Much of the produce is hauled back to the farm because there isn't sufficient demand at the high price level.

The result of all this inefficiency is high prices to the consumer. The consumer has three choices to make. They are: (1) pay the high price, (2) go without vegetables, or (3) grow their own. The last choice is made by many, who grow a substantial percentage in back-yard gardens. This adds to the confusion in the markets. The commercial grower must largely avoid production of those vegetables that are in season for the back-yard gardener. His sale volume is so low during the best season for him to produce that he has to get higher prices during the time of year the back-yard is out of production. He is forced to obtain a major part of his living during the season of high production costs. Where the price is high enough under these conditions to cover the cost of production it is too high for many customers, so that the market may become glutted. Boiled down to a simple statement, the market cannot depend on the consumer, and the consumer cannot depend upon the market.

Is there any way out of this dilemma? I believe there is a way. It should start with the greengrocer and the grower at the same time. The greengrocer would have to contract with the grower and take all of his produce of suitable quality at a lower price than the grower would get for a portion of his crop in the open market. The greengrocer could move his produce at a lower price and thus attract more consumers. The larger the number of consumers, and the greater the volume, the smaller profit per unit is needed. This would decrease the need for the back-yard garden and its usually low quality of produce. Gradually the market could depend on the consumer, and the consumer could depend upon the market. Naturally under such a system the inefficient, be he either grower or greengrocer, would be eliminated as he is in any other type of business. One may ask if it is a good thing to advocate practices that would force a grower or businessman out of business. My answer to that is that the consumer should never have to pay for inefficiency. Inefficiency never creates wealth in any country.

The importance of large scale and mechanized production

By this time the reader of this article has undoubtedly arrived at the conclusion that I am an advocate of large scale production. That is true. It is my viewpoint. It is the only one I have. As explained earlier, my experience has only been in contact with large scale production. That is "America". Mr. David O. Lilienthal, Chairman of the Atomic Energy Commission, in speaking of production of durable goods says, "The people of the United States of America now produce as much as all the rest of the world put together. This we do with a mere 6 per cent. of the world's population and about the same percentage of its land area. And we are only at the beginning; we shall probably multiply this production over and over again in the next ten to twenty-five years. There was an old dream: the independent man in his own little shop or business. It *was* a good dream. There is a new dream: a world of great machines, with man in control, devising and making use of these inanimate creatures to build a new kind of independence, a new source of pride of achievement, beauty and humaneness".

The impact of large-scale industrial production on agriculture in the United States has a tremendous effect on agricultural thinking. It provides agriculture with machinery, pest control material and equipment, fast transportation, and processing and refrigeration equipment; and it forces agriculture to think in these terms. Fortunately the United States has large areas of deep fertile soil with a suitable climate. Where rainfall was insufficient, large irrigation projects have been developed. Could agriculture be kept from being swept along with large-scale production?

Recommendations

I have been asked to make specific recommendations whereby Australia might improve her present vegetable production. Let me state clearly that I believe no one can write a simple formula for this situation. If the formula were simple it would have already been written. Merely the fact that the small-scale operations now in vogue are not giving an adequate supply of vegetables at a price the consumer can pay does not imply that the large-scale production of California should be adopted without severe alterations. Large and small are relative terms. How big is large-scale farming, and how little is small-scale farming? These are questions that can only be determined by trial and error under Australian conditions. These conditions will change as the future of Australia unrolls. He would be a wise man indeed who could predict how the future will unroll. I would like to point out that Australia did produce and process vegetables during World War II. She did this with little past experience and only a very little outside help. The ability is there if the right men can be stimulated into action. This has been demonstrated beyond question. High prices do not appear to be the proper stimulus. Is it the fear of high income tax, risk of capital, lack of labour, lack of machinery, lack of housing material for labour that is holding down production? Or is it that Australia just doesn't care? I know the latter is not true, for some of the men I met are very earnest men who are seriously concerned about Australia's welfare. These men realize that production must be increased if Australia is to remain a free nation in today's hungry world.

I would like to offer a few suggestions —not that they will be a panacea, but they might help someone to think of a better solution. I think that Australia's problems must be answered by Australia. She alone can determine what fits her needs.

1. *Develop an Extension Service for Agriculture that will bring research and agriculture together. This should be an educational organization that*

can recognize the real problems in Australia and help in their solution.

2. *Let all the phases of the industry get together to see that educational facilities are available to train personnel to think, whether it be on the farm or in the factory. No industry can have too many men trained to think.*

3. *Let processing industry get together with the growers and work out a set of standards, under which they will operate in such a manner that the quality of the Australian products will have world-wide recognition.*

4. *Expand the basic ideas of the Institute of Food Technology to other phases of the industry, such as the field officers, plant breeders, and growers.*

5. *Foster trips to other countries for men in all levels of the agricultural industry with the purpose of studying the successes and failures of the vegetable industry in foreign lands. I am amazed at how much I learned about the United States during my stay in Australia.*

6. *Establish a periodic open forum where all phases of the industry get together to discuss its problems and to check on its progress. It is essential for one phase of an industry to appreciate the problems of another phase.*

7. *Augment the programme of research at farm level, with funds and personnel. There is a great need for this work in Australia.*

In conclusion, let me say that regardless of the harsh and perhaps unjustified criticisms I have offered above, I believe the vegetable industry in Australia has a great future. I realise it is a young industry. The young must learn to crawl before they can walk or run. My great concern is the mental crippling by regimentation of this young industry. There are some great men in it. I have met and talked with them. I sincerely hope that somehow these men may be brought together so that their thinking may be focussed on the industry. I travelled about Australia through the courtesy of these men, and I am most grateful that I have had the privilege of working with them. The above criticisms reflect my concern, not my lack of gratitude. I do not believe anyone could have enjoyed the experiences that I did without having the highest regard for these outstanding men and a soft spot in his heart for Australia.

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THE IMPORTANCE OF ANIMAL BEHAVIOUR STUDIES IN ANIMAL PRODUCTION

By D. E. TRIBE

The investigation of problems of animal behaviour is to the agriculturalist an interest which is both new and popular. Indeed, the novelty itself may have contributed very largely to the popularity. During the last six or eight years such studies have enjoyed the attention of agriculturalists in increasingly large numbers from all parts of the world and it is appropriate that we should now pause and reflect upon the progress that has so far been made and the lines along which future studies should be centred.

GRAZING BEHAVIOUR

The majority of animal behaviour investigations have been carried out with grazing animals. Agronomists and grassland ecologists have become increasingly aware of the need for a fuller understanding of the animal complex and a study of its relationship with the plant complex, and as a contribution to this general problem many studies of grazing behaviour have been commenced. It was thought that a finer appreciation of grazing habits would assist in making an accurate evaluation of pasture efficiency, and some have even suggested that the records of grazing behaviour themselves can serve as valid criteria of methods of pasture or animal management. Now that a considerable number of experimental and observational reports have become available, it is clear that the latter claim is manifestly unjustifiable. Before considering these results, attention must first be paid to the various methods of obtaining them.

Techniques of recording grazing behaviour

Valid and standardised techniques are the prerequisites of any scientific investigation. It is an important criticism of grazing behaviour studies in all parts of the world that there is no standardised technique of observation and no comparison has yet been made of the accuracy of the many different methods now used.

There is, for instance, no uniformity concerning even the period during which observations should be made. Cory (1927) assumed that the duration of an "animal-day" was 13 hours 36 minutes, while Hodson (1933) made his recordings from 6.0 a.m. until dark; Moseley, Stuart and Graves (1929) from 5.0 a.m. until 9.0 p.m., and Atkeson, Shaw and Cave (1942) assumed an "animal-day" of 11 hours 40 minutes. Many other workers, e.g., Castle, Foot and Halley (1950), Tribe (1949), and Hancock (1950) have recorded for continuous periods of 24 hours of even longer.

Similarly, methods of recording may vary considerably. Some workers record the behaviour of individual animals, while others record the behaviour of flocks or herds. Some workers make a continuous recording, while others record observations taken at regular and frequent intervals. Some records are the work of single observers, while others are made by several observers working a shift system. Until investigations have been made to assess the comparative reliability of these various techniques, it is not possible to explain satisfactorily the different results which have been reported.

The results of grazing behaviour records

That there exist important differences between the behaviour patterns described by various workers is not surprising. In

D. E. TRIBE, B.Sc. (Agric.), Ph.D., is Lecturer in Animal Husbandry in the School of Veterinary Science, University of Bristol.

addition to the discrepancies due to differences in observational techniques, there is a complex of environmental factors which must be expected to influence critically a "normal" pattern. For example, the effect of the climate and, in particular, high temperatures upon the behaviour of grazing animals has often been noted. Bonsma (1940), working in South Africa, found that on a particularly hot day when a maximum of 103°F. was reached Afrikander animals spent 89 per cent. of the day (8.0 a.m. to 5.0 p.m.) grazing compared with 79 per cent. for Herefords, 78 per cent. for Shorthorns and 75 per cent. for Aberdeen Angus. Observations of 24-hour grazing periods made by Seath and Miller (1946) in America showed that during two relatively warm days cows grazed less than two hours, 1.9 and 1.8 hours during daytime (between a.m. and p.m. milking periods) but grazed three times as much, 5.7 and 5.5 hours, at night (between p.m. and a.m. milking). Data on two cool days showed daytime grazing 2.4 times as great as for warm days, and 24-hour grazing totals more than one hour longer than for warm days. Hancock and Wallace (1947), working in New Zealand, found, however, that hot weather (77°F.) depressed overall grazing times but did not alter the day and night grazing ratio.

The size and nature of the paddock in which animals are enclosed also influences behaviour. Shepherd (1921) showed that the bigger the paddock the further animals tended to walk, and this fact might help to explain the differences in the results of more recent workers.

Many factors such as the density and quality of the sward, the climate, the feeding of supplements in the field, the size of the paddock, perhaps even the animal's own endocrine balance, will all influence the number of hours which an animal will spend grazing. Table I shows how the the results of workers may vary. Such results can mean little outside the confines of their own experimental conditions for even if we know how many minutes are devoted to the various activities of grazing animals, of what general use is such information?

From this brief discussion of the factors which may influence the results of grazing behaviour investigations, it will at once be seen that restraint must be exercised on the tendency to draw rather wide conclusions from them. Certainly the general application of a particular set of results in different environments is not justifiable. Within the circumscribed conditions of a particular investigation, however, the results obtained from animal watching may be of the greatest value.

TABLE I

The Number of Minutes Per Day which Cattle Spend Grazing

Author	Type of Animal	Grazing Time (min.)
Hodgson; 1933	Dairy Cattle	411-439
Hancock and Wallace; 1947	,,	403
Hancock; 1950	,,	410
Castle, Foot and Halley; 1950	,,	390
Waite, MacDonald and Holmes; 1951	,,	552
Cory; 1927	Beef Cattle	461
Shepperd; 1927	,,	495
Johnstone-Wallace and Kennedy; 1944 ..	,,	452

The object of grazing behaviour studies with domestic stock is an increased efficiency of animal production. It may be legitimately argued that a fundamental understanding of behaviour will ultimately lead to improved methods of animal management for optimum production since "a fuller knowledge gives a fuller control". However, it must be remembered that this is not the only way of gaining a "fuller knowledge", and, from a short-term view at any rate, it is probable that other types of animal experimentation will give better dividends in terms of animal production. This does not mean that behaviour studies have no application in animal husbandry in the near future. When carrying out animal production trials it is frequently necessary to make behaviour observations before the results obtained are fully understandable. Levy (1935), for example, used this technique when solving the problem of feed flavour in butter in New Zealand, and the studies of Doran (1943) and Stoddart and Rasmussen (1947) have shown how observation on sheep grazing habits can help to increase the efficiency of management on American ranges. Thus, as an appendage to a managmental investigation behaviour studies may often be invaluable, but as independent investigations their bearing on animal husbandry is at present limited.

Palatability studies

The results obtained from continuous periods of animal observation can explain the "how", "when" and "where" of grazing, but there still remains the "what" and "why". A large number of palatability trials has been reported which indicate plant preference orders chosen by grazing the animals under a variety of conditions. These results make it clear that the old notion that a degree of palatability was a characteristic of a plant in the same absolute sense as its earliness, hardiness or persistency is mistaken, and that the palatability of a plant has not the same general importance as used to be attributed to it.

It is now clear that palatability is a function of the animal rather than of the plant since it is the action of the animal in accepting or rejecting a food, ultimately explainable in terms of special sensory reactions, that assigns to the food its degree of palatability. Of course, the condition of the plant can have a great influence upon the animal's behaviour, but this is only one of a number of factors which includes all the varying conditions of the environment and the animal's metabolism. For example, in the eighteenth century Linnaeus (1749) showed that different animal species react differently to the same plant species. What is palatable to a dairy cow may be unpalatable to a sheep. Differences in plane of nutrition also have parallel differences in food selection, and as Katz (1937) has indicated, the law of substitution may be applied to dietary preference. As the need for food increases the self-imposed standards of palatability tend to sink and, in cases of great need, animals will readily consume material which is not only labelled "unpalatable" in text books, but even that which is completely indigestible and even poisonous. There is abundant experimental evidence to show that variations in the palatability of a single plant may be caused by temporal and spacial differences, and simple genetical differences in taste sensitivity within an animal species have been demonstrated.

Cockayne (1919) has shown how fickle the palatability of a single plant may be. He quoted the work of five people who had studied the palatability of *Agropyron scabrum*, and he indexed their results from 1 to 5. The work of Petrie gave an index of 5, that of Armstrong 4, Kirk 3, Buchanan 2, and Cockayne 1. Similarly, the result of Davies (1925), Beaumont, Stitt and Snell (1933), Tiemann and Mueller (1933), Schneider-Kleeberg (1932), Hopper and Nesbitt (1930), Wilkins and Hughes (1932), and Garrigus and Rusk (1939), all contradict each other to varying degrees.

DIETARY SELF-SELECTION EXPERIMENTS

It is popularly supposed that one of the more important factors which decide whether, and to what degree, food is selected by an animal is the nutritive value of the food itself. In 1923 Tscherkes observed that fowls suffering from polyneuritis will search out green food and refuse to accept grain, and this he described as a "triumph of instinct". More recently Sir George Stapledon (1948), when discussing the nutritional wisdom of farm animals, has assumed that "the animal has an instinctive drive to endeavour to satisfy *all* its nutritional needs."

This subject is of importance for two reasons. Firstly, there are obvious economic advantages in a "cafeteria" system of feeding for fattening cattle, pigs and poultry which are housed indoors. Secondly, grazing animals are inevitably on a self-selection system of feeding and if they do possess an appetite instinct then it follows that the behaviour of a grazing animal is a legitimate criterion of the nutritional status of the pasture on which its grazes. Translated into practice, this means that when animals are observed, as they often are, eating weeds, and perhaps bushes, when enclosed in a highly productive modern ley, it is right to conclude that they are following the dictates of their instinct and that there is some essential nutrient in the weeds that is missing from the sown herbage. Therefore, it follows that farmers should plant weeds, or herb strips, in their fields and so satisfy the nutritional requirements of the grazing animals and with no experimental backing at all this system is in fact being widely advocated and being practised at the moment in Great Britain. Since the production of total digestible nutrients from weeds is very much lower than from the same area of modern strains of grasses and clovers, this question has a very considerable bearing on the total yield of animal products from a unit area of grassland, and such a system must clearly have experimental verification before it can expect general recognition.

As Harris and his associates at Cambridge (1933), pointed out, it is very unsatisfactory to let this matter be ascribed vaguely to some unexplained "instinct". Are animals in fact able to select their own diets according to their individual nutritional needs? If so, what are the limitations to such powers of recognition, and what is the mechanism involved?

Many workers have interested themselves in the answer to these questions and much work has been reported on a variety of animal species under a variety of conditions.

A great many dietary self-selection experiments have been carried out with rats, and the results obtained from these reflect the same kind of disagreement shown by experiments with other species. It is usual to confront the rats with a wide choice of all the necessary basic foodstuffs, in solid and liquid form, in a so-called "cafeteria system" of feeding. With such a system as this some observers have found that rats select a diet which closely agrees with that prescribed by nutrition experts, and under these conditions the animals grow and reproduce at a rate comparable to that of rats fed well-balanced laboratory stock diets. Other investigators, however, have been unable to reproduce these results and indeed some have failed to demonstrate any ability on the part of the rat to select an adequate diet when fed on a free choice system. Similarly, studies carried out on rats deficient in certain nutritional requirements have in some instances demonstrated selection of the missing item and in other cases rats have consistently refused to eat the necessary nutrient and have thus committed virtual suicide. For instance, Richter, Holt, Barelare and Hawkes (1938), reported that rats deprived of vitamin B developed a craving for this vitamin, while Wilder (1937), found that a tendency to select an unfamiliar diet counteracted the selection of an anti-

rachitic diet by rats previously subjected to a rachitogenic diet. The rats selected the novel food whether or not it corrected their deficiency.

Scott (1948), working at the University of Pittsburg, has done a series of carefully controlled experiments on the self-selection of diet by rats. He has found as have other workers that sometimes a rat chooses a good diet and sometimes a bad, and has classified appetites under three headings: true hunger, trivial preferences and learned appetites. The desire for food as such is the only true hunger. Trivial preferences are most familiar in everyday life. They include preferences for a pleasant taste, a satisfying smell, or an attractive texture and are in no way related to nutritive value. Learned appetites include that of the vitamin B deficient rat for a diet containing vitamin B. As Harris concluded from his original observations the apparent nutritional wisdom of animals is not due to an inherited instinct for the right food but rather to a previous experience of the beneficial results which follow its consumption. In place of "a little of what you fancy does you good" one might write "you get to fancy a little of what did you good promptly".

Research with farm animals has given results which lead to essentially the same conclusions as that with rats.

American workers have compared the egg production and body-weight gains of 60 chickens on a help-yourself system of feeding with those of 60 birds fed a standard poultry mixture. Here the birds that selected their own diets were better producers and showed a better efficiency of food utilisation than those on the mixture. However, trials in which calves and heifers were allowed free access to maize, oats, linseed meal, wheat bran, and other protein supplements showed that those animals did not know what was best for them and chose a diet on which they steadily declined in body-weight and vigour. Similarly, an experiment in which pregnant ewes were allowed to choose their own diet from the constituents of a balanced ration showed that an unfortunate selection resulted in a very bad lambing performance.

From this and similar evidence, we can conclude that feeding behaviour is not an infallible guide to physiological requirements. Sometimes an animal eats what is good for it and at other times it does not. The answer to our husbandry question is thus clear. Do not base a system of animal or grassland management on recorded observations of animal behaviour. There is no sound basis for a completely *ad lib* system of feeding.

DISCUSSION

Animal behaviour studies can be classified under two headings. Firstly, there are those behaviour observations which are part and parcel of any research involving live animals. Inevitably, the biochemist, physiologist, geneticist, agronomist, and so forth, all have to have a knowledge of the behaviour of their animals under their experimental conditions before they can either design satisfactory experiments or fully appreciate the significance of the results obtained. Such studies as these are not really "behaviour studies" as such and it has been suggested that if they are to be given any particular name then "misbehaviour studies" seems to be more appropriate! Unfortunately, there is a very real tendency for workers in various fields of animal research to devote a considerable amount of time and energy on the pseudo-problems of animal behaviour, or more correctly, problems that are real to the ethologist but pseudo to the biochemist, physiologist, geneticist, agronomist and so forth. As Pirie (1951), has observed:

> "A scientist can have no more valuable skill than the ability to see whether the problem he is investigating exists and whether the concepts he is using are applicable. But the lure of a concept that clarifies another field is strong

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and many of us follow it, like the music of the Pied Piper, to our scientific detriment."

The other type of behaviour study is that carried out with the sole purpose of studying the reasons for an animal's actions, and is best carried out by people who are largely indifferent to the possibility of applying their findings to animal husbandry. Those whose main interest is increased production are better advised to follow other lines of enquiry since their activity in the fields of behaviour frequently only serves to confuse the issue for their colleagues, and will certainly not lead to any quick or revolutionary method of improving the efficiency of animal production. The argument which some are inclined to advance that the desire to study animal behaviour for its own sake and without reference to husbandry is "merely academic and should therefore be avoided" is misleading. The history of scientific investigation teems with examples of the reciprocity of interests between the fundamental and the applied, the theoretical and the practical, the abstract and the concrete. In various fields of enquiry it has been shown that not only does the elucidation of abstract principles open up new pathways for practice, but, conversely, that the minutest details of practice provide a stimulus for thought and a challenge to experiment without which "thought languishes in the empty framework of its own categories, and experiment, lacking a fulcrum, fails to secure sufficient leverage". If studies of the behaviour of farm animals are to be of value then their principles must be rationalized and their techniques specialised. Most important of all, the present tendency to base systems of animal and pasture management upon behaviour observations, or to use behaviour observations as the criterion of good management, must be exposed as irresponsible lest the damage this does to the general reputation of ethological investigations should embarrass the more legitimate studies in this field.

References

Atkeson, F. W., Shaw, A. O., and Cave, H. W. (1942).—*J. Dairy Sci.*, **25**: 779.

Beaumont, A. B., Stitt, R. E., and Snell, R. S. (1933).—*J. Amer. Soc. Agronom.*, **25**: 123.

Bonsma, J. C. (1940).—*Fmg. S. Afr.*, **15**: 7.

Castle, M. E., Foot, A. S., and Halley, R. J. (1950).—*J. Dairy Res.*, **17**: 215.

Cockayne, L. (1919).—*N.Z. J. Agric.*, **18**: 321.

Cory, V. L. (1927).—Bull. Texas Agric. Exp. Sta. No. 367.

Davies, W. (1925).—*J. Minist. Agric.*, **32**: 106.

Doran, C. W. (1943).—*J. Forestry*, **41**: 253.

Garrigus, W. P., and Rusk, H. P. (1939).—Bull. Univ. Ill. Agric. Exp. Sta. No. 454.

Hancock, J. (1950).—*N.Z. J. Sci. and Tech.*, **32**: 22.

Hancock, J., and Wallace, N. M. (1947).—Proc. 7th Ann. Conf. N.Z. Soc. Anim. Prodn. p. 145.

Harris, L. J., Clay, J., Hargeaves, F. J., and Ward, A. (1933).—*Proc. Roy Soc.*, **113***B*: 161.

Hodgson, R. E. (1933).—*J. Agric. Res.*, **47**: 417.

Hopper, T. H., and Nesbitt, L. L. (1930).—Bull. N. Dak. Agric. Stn. No. 236.

Katz, D. (1937).—"Animals and Man." Studies in Comparative Psychology. (Longman Green and Co.).

Levy, E. B. (1935).—*N.Z. J. Agric.*, **50**: 140.

Linnaeus, C. (1749).—Pan Suecus, Amoenitates Academicus. **2**: 225.

Moseley, T. W., Stuart, D., and Graves, R. R. (1929).—Tech. Bull. U.S. Dept. Agric. No. 116.

Pirie, N. W. (1951).—*Science News*, **25**: 7. (*Penguin Books Ltd.*).

Richter, C. P., Holt, L. E., Barelare, B., and Hawkes, C. D. (1938).—*Amer. J. Physiol.*, 122: 734.

Schneider-Kleeberg, K. (1932).—*Dtsch. Landw. Tierz. Beilage Weidew. u. Futterban.*, **7**: 13.

Scott, E. M. (1948).—*Trans. Amer. Assoc. Cereal Chem,*. **6**: 126.

Seath, D. M., and Miller, G. D. (1946).—*J. Dairy Sci.*, **29**: 199.

Shepperd, J. H. (1921).—Bull. N. Dak. Exp. Sta. No. 154.

Shepperd, J. H. (1927).—Bull. N. Dak. Exp. Sta. No. 211.

Stapledon, R. G. (1948).—Proc. N.V.M.A. Conf. Grassl. and Anim. Health.

Stoddart, L. A., and Rasmussen, D. I. (1947).—Circ. Utah Agric. Exp. Sta. No. 121.

Tiemann, A., and Mueller, G. (1933).—*Arch. Tierernahr.* **9**: 253.

Tribe, D. E. (1949).—*Emp. J. Exp. Agric.*, **17**: 105.

Wilder, E. C. (1937).—*J. Comp. Psychol.*, **26**: 135.

Wilkins, F. S. and Hughes, H. D. (1932).—*J. Amer. Soc. Agronom.*, **24**: 18.

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FARM INCOMES IN AUSTRALIA

By SHEILA ROWLEY

Introduction

Probably nine out of ten readers of this article will be salary-earners like myself. There is nothing in farming comparable to our regular weekly or monthly pay-cheques, for we know at the beginning of each year the amount we shall receive: a farmer never knows that, because both seasonal conditions and farm prices fluctuate. We have a recognised machinery for adjusting salaries and wages to changing costs of living: the farmer has no such machinery. Farmers suffer from irregular and unpredictable incomes, and they have no satisfactory machinery for securing changes in their income commensurate with changes in their costs.

Income Like a River

To get right away from the idea of "income" as a static object, denoted by three, four or more figures with a "£" in front of them, I suggest we think of income as something flowing like a river, now fast, now slow, sometimes quite dry: sometimes sliding sluggishly by in a broad sheet of water, sometimes rushing swiftly through a deep chasm. Just as the flow of a river is more variable than the level of water in a lake or an ocean, so is income far more variable than wealth. Wealth is tangible and static: income on the other hand is elusive and turbulent. If income is to be measured at all, it must be measured in a state of flow. I suggest that we compare the flow of a river to the aggregate flow of income to all farmers in Australia. Imagine that across each tributary of a river there is a net or grid, and think of the mesh in the net as dividing up the flow of the river into a number of minute flows. The total flow of a tributary at any point is equivalent to the aggregate flow of income from **one** farm product to all farmers concerned; the flow down the main channel, after all its tributaries have joined the river, is equivalent to the aggregate flow of income from **all** farm sources to all the farmers in Australia. The amount of water passing through one hole in a net across a tributary is the income one farmer receives from one product alone, say wheat. The number of holes in the nets across all the tributaries is obviously greater than the number of holes in the net across the main channel, the latter being equivalent to the number of farmers in Australia. Just as the features of each tributary stream may vary, so the features of income vary as between the pastoral, wheat and dairying branches of the farming industry.

Average Farm Income

It is well known that engineers measure the flow of a river in "cusecs" (or cubic feet per second). The formula they use for finding the flow of water at any point is—

> Flow (in cusecs) = Cross-sectional area (in sq. ft.) **times** average velocity (in ft./sec.).

Clearly, by analogy, our formula would be—

> Aggregate income (in £s p.a.) to the farming industry = Number of farmers **times** average income (in £s p.a.).

We may notice that to determine flow, engineers have to calculate the **average velocity** of the water between opposite points on the banks. The water usually moves faster in the centre and slower at the sides of a stream, so that the average rate is no more than a convenient device for measuring a representative velocity

MISS SHEILA ROWLEY, M.A., is Research Fellow in Agricultural Economics Institute of Agriculture, University of Western Australia.

for the river as a whole. Similarly, in farming, there are always farmers who receive larger incomes, and others who get smaller ones. An **average farm income** is a useful device for certain purposes, but no amount of averaging does away with the real variability in farm incomes.

Recent Work in Australia

I shall briefly review here some of the recent work in Australia on farm incomes. I will deal first with articles in which empirical findings are presented, and then with articles containing discussion but no original empirical findings. The empirical work divides itself fairly clearly into two groups: in the first group of papers farm income is measured, like national income, as an "aggregate," while in the second group of papers farm income is treated as a "frequency distribution."

(1) Empirical Results

(a) *Farm income as an aggregate*:

Pawley (1945) presented graphs (without supporting tables) showing his estimates of aggregate gross income in Australia from 1912 to 1942; he presented his results in diagrams 1 and 2, showing respectively "nominal" farm income, and "real" farm income, the latter being derived from "nominal" by recalculating it in 1923/1927 prices.

He also presented in diagram 5 (again without a table) his estimate of aggregate net farm income from 1928 to 1942. Pawley mentioned at the outset that he had used official statistics as his source. He wrote:

> "One way of securing information on farmers' incomes is by the study of individual cases, so selected as to provide as representative a sample as possible for a given industry or district. This, however, is a long-range and painstaking task."

McKay (1950) and (1951) also compiled figures of aggregate farm income.

A more recent and far more elaborate undertaking than the foregoing, which is nevertheless on somewhat the same lines, is that of Youngman (1952). He built up a series of estimates of farm income, according to several definitions, covering the years 1947/1948 to 1951/1952, and presented his results in tables, without graphs. As far as it goes his work is careful and useful, but it is only fair to quote his own opinion of the work:

> "The main shortcomings, however, are those occasioned by lack of adequate information about farm costs, and the main conclusions to be drawn from our investigations so far may well be that it is necessary to collect far more material, and far more carefully than has been done to date, before really satisfactory estimates of farm income can be prepared."

The point I want to make about all estimates of aggregate farm income is this: just as an irrigation expert may stand beside a channel and say, "I reckon the flow is 20 cusecs," so statisticians and economists may make guesses about aggregate farm income. The accuracy of their results must be taken on trust; it depends on the experience of the engineer or the economist who does the guessing. As no one in Australia has ever checked these aggregates of farm income by carefully designed Australia-wide surveys, we can afford to be sceptical of their accuracy if we choose.

(b) *Farm income as a frequency distribution*:

Statistical methods have been developed which enable us to summarise a mass of figures concisely and with known accuracy. By the calculation of a mean, for example, we may present results in a short form, and discard many observations which for a particular purpose may be irrelevant, but writers on farm incomes have shown an unwillingness to avail themselves of even the simplest of statistical devices. The first step in analysis is usually to sort a set of measurements and

tabulate them in the form either of an array, or a frequency distribution with arbitrarily determined class intervals. Roberts (1944) may be instanced as one writer who presented his empirical findings unsorted, simply by giving in tabular form the results for each of the 23 farms in his survey. In the text he mentioned the range of incomes, but not the average. Druce displayed a similar reluctance to present averages. Throughout three papers (1946), (1948) and (1949) in which he dealt with the financial position of wheat-sheep farms (22 farms in 1944-1945, 18 farms in 1945-1946, and 15 farms in 1946-1947) Druce only presented one set of averages. Significantly they were averages for five farms all of a similar size, and in the same locality and in the same year. He explained the omission of other averages as follows:—

> "In view of this variation in the size and organisation of the farm studied, average figures for all the owner-operated farms, whether they be averages of income and returns, capital invested, or income and expenditure would be well-nigh meaningless and possibly quite misleading."

Vaidyanathan (1946), on the other hand, presented averages of the financial position of the 38 wheat farms he analysed. He wanted to compare results in the South Western Slope with those in the Riverina district, and for this reason was forced to summarise the figures for each district in some way. Unfortunately he did not present his original tabulations in full, nor did he give any indication of how he calculated the averages he presented.

Owen (1947) analysed the financial position of 32 dairy farms, and presented his tabulated results and averages. He explained:—

> "It must be emphasised at the outset that the farms discussed can by no means be taken as a representative sample for New South Wales. For example, many books received from farmers were so incomplete that a satisfactory analysis could not be achieved, and in general it is found that it is the more progressive farmer who keeps the best records. Therefore, while averages have been calculated from some tables, these must not be interpreted as average figures for the State as a whole."

Davis and others (1951) analysed the financial position of 29 woolgrowers in one area and 31 in another; they presented some of their results in the form of averages, but more often in tables in which the individual values were grouped into class intervals.

The results of empirical work analysed by each of the authors mentioned above have one thing in common—the size of the sample of farms is small, ranging from 15 to 38 farms. Moreover, the areas surveyed were often quite small localities, comprising only a few hundred square miles.

Before leaving this section I must mention another kind of average which is derived by dividing one aggregate (gross farm income, say) by another aggregate (number of farmers in Australia, say). Pawley (1945), for example, presented in diagram 13 (with no supporting table) the results of dividing aggregates of farm income in N.S.W. from 1928 to 1941 by aggregates of numbers of farm operators in N.S.W. in the same years. Averages resulting from such calculations obviously have all the weaknesses earlier attributed to the calculation of "aggregates", and cannot be ranked on a par with averages derived from frequency distributions.

(2) Discussions

I can only mention here a few of the authors who have discussed farm incomes in Australia recently. The present author, Rowley (1947), endeavoured to show the algebraically necessary rela-

tion between farm costs and farm incomes, and set out in formula (14) the "sideline-deduction" method of calculating unit costs. Owen (1948) and Campbell (1950) discussed farm incomes fairly fully in relation to general agricultural policies. They both remarked that farm incomes are highly variable, not only as between farm and farm, but also as between the average farm income of different years. They both seemed to think that something should be done about reducing the annual fluctuations in average farm income, but neither was enthusiastic about price-fixing as a method of stabilising farm incomes. Finally Date (1950) reviewed the method by which farm prices are fixed in Britain, in these words:—

> "An endeavour is apparently made to assess the net earnings of agriculture over a period of twelve months, and with this as a basis for achieving the objective of maintaining the stability of the net income of farmers, the overall total is broken down to arrive at reasonable returns for individual farm products."

It would take us too far afield if we embarked upon any consideration of the various definitions of farm income, including "gross farm income", "net farm income", "operators' labour income" and such concepts. Nor do I propose to pursue the question of how various authorities make adjustments for cheap family labour and home-grown food.

Objectives for Future Work

The period of deflation which almost all economists expected after World War II has not yet arrived, but I suggest that it is not too early for us to be evolving sounder farm policies than any we have yet known, so that agriculture may weather the storm when it comes. Can studies of farm costs and farm incomes tell us anything which will be useful in guiding us to wise agricultural policies in the near future? I think they can.

First, let us digress to compare our position in Australia today with that in the United States in the decades following the Civil War. Parkes (1949) described how farm production more than doubled in the United States in the years from 1860 to 1900, while farm prices fell continuously. Quoting:—

> "This process was intensified by the deflationary policies, beneficial to bankers and creditors, that were being pursued by the federal government. . . . American statesmen continued to insist that the small independent farm owner was the healthiest element in the nation and therefore deserved special consideration. This was true, insofar as the farmers had always been the chief representatives of American ideals. . . . But it was evident that, without some fundamental change in public policy, the farmers could not maintain their traditional place in the community."

We, too, need a fundamental change, and it cannot come too soon to save something which is a valuable part of our Australian heritage—the way of living of our farmers.

The foregoing review of literature underlines how little we know of farm incomes in Australia. A useful objective to set ourselves would be to determine the frequency distribution of farm incomes throughout Australia for some particular year, say 1952/53, by means of a sample survey. From the records of such a survey both the aggregate and the average farm income for Australia could be estimated, with a relatively small sampling error. So far, the pure economists have not attempted to measure aggregate farm income from surveys in this way: they have simply measured aggregates from official statistics. The accurate measurement of farm income by surveys is a task awaiting the agricultural economists of the future. To achieve worthwhile results we shall have to raise our sights and aim at something better than 30 or so farms per survey.

As agricultural economists, our interest in farm income is in average farm income, the dispersion about the average, and the reasons for that dispersion. The region or group of farms surveyed, for which averages and dispersions are measured, should be chosen sufficiently large to have a recognisable character of its own. To pursue this subject further would lead us into the intricacies of the design of sampling surveys. Suffice it to say that the objective of statisticians, who assist us to design surveys, is to ensure that we use scarce resources to obtain maximum results for minimum effort.

One way in which I believe we have wasted our scarce resources in the past was by conducting surveys of costs and not at the same time measuring incomes. This procedure was tantamount to going upstream and netting some of the tributaries and failing to net the main channel of the river itself. Surveys of the costs of individual commodities, such as those we witnessed in the wheat and dairy industries of Australia in 1947, can by themselves tell us very little, because it is not absolute but relative costs which we should be measuring. If surveys were made simultaneously in all our staple farm industries, we should at least discover the relative costs of our staple farm products, information which would be a useful guide in the event of price fixing remaining in favour. To be fully effective, however, we should require that future surveys link a study of costs and income. In this respect, we might learn something useful from the methods used in British reviews of farm prices.

References

Campbell, K. O. (1950).—*J. Aust. Inst. Agric. Sci.*, **16**: 144-53.

Date, A. (1950).—*Aust. Quart.*, **22**: 36-50.

Davis, K. O., Carney, J. P., Reid, P. A., Strong, T. H. (1951).—Regional Studies of the Aust. Woolgrowing Industry.

Druce, P. C. (1946).—*Rev. Market. agr. Econ., Sydney*, **14**: 319-35.

Druce, P. C. (1948).—*Rev. Market. agr. Econ., Sydney*, **16**: 5-17.

Druce, P. C. (1949).—*Rev. Market. agr. Econ., Sydney*, **17**: 185-196.

McKay, D. H. (1950).—*Quart. Rev. agric. Econ.*, **3**: 153-5.

McKay, D. H. (1951).—*Quart. Rev. agric. Econ.*, **4**: 23-25.

Owen, W. F. (1947).—*Rev. Market. agr. Econ., Sydney*, **15**: 123-146.

Owen, W. F. (1948).—*Rev. Market. agr. Econ., Sydney*, **16**: 289-314.

Parkes, H. B. (1949).—American people: their civilisation and character. Oxfd. Univ. Press. p. 287.

Pawley, W. H. (1945).—*Rev. Market. agr. Econ., Sydney.*, **13**: 84-174.

Roberts, R. P. (1944).—*J. Dept. Agric. W.A.*, **21**: 171-96.

Rowley, S. (1947).—*Econ. Record*, **44**: 58-65.

Vaidyanathan, P. (1946).—*Rev. Market. agr. Econ., Sydney*, **14**: 83-90.

Youngman, D. V. (1952).—Paper read at Sydney meeting of A.N.Z.A.A.S., mimeo. The estimation of farm income.

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A MESSAGE FROM THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

The American Association for the Advancement of Science appreciates this opportunity to introduce itself to the Australian Institute of Agricultural Science, and it extends its hearty greetings and good wishes to a sister organization that is advancing science and the applications of science on the opposite side of the globe.

The AAAS, despite its earnest effort to be all things to scientists in the United States, is not in a position to boast of its activities in the field of agriculture, although it is by no means indifferent to this important subject. Of its 48,000 members, a scant 1,400, or 3 per cent. list themselves as agricultural scientists—a number that represents only a fraction of the agricultural scientists in the United States Department of Agriculture and its experiment stations (approximately 9,500, including technical aids). It is not, of course, the aim of the AAAS to function as an agricultural society, although it attaches sufficient importance to this diversified field of scientific endeavour to have a separate Section on Agriculture.

Affiliated with the Association, and specifically with the Section on Agriculture, are the American Society for Horticultural Science, American Society of Agronomy, American Society of Animal Production, Society of American Foresters, American Dairy Science Association, American Pomological Society, Association of Official Seed Analysts, Gamma Sigma Delta (the Honour Society of Agriculture), Potato Association of America, Soil Conservation Society of America, Xi Sigma Pi. These 11 societies are among the 238 officially affiliated or associated with the AAAS.

The AAAS publishes two journals—the weekly, *Science,* with a circulation of approximately 32,000 and *The Scientific Monthly,* with a circulation approximating 27,000. About 10 per cent of the articles submitted for publication in both these periodicals bear upon agriculture, hence the representation of the subject is somewhat better in the Association's journals than in its membership. In the publications, meetings, and other activities of the AAAS, there is no attempt to compete with the specialized functions of individual societies, hence most of the manuscripts accepted for publication have their base in such pure sciences as chemistry, botany, physics, zoology, and geology; and most of them are thus of interest and concern to scientists in two or more fields.

Since it is a major objective of the Association to serve as a medium of integration for scientists in two or more disciplines, it was natural, therefore, that the Section on the Social Sciences collaborated with the Section on Agriculture in the symposium on Combined Research Development at St. Louis in 1952; and that the Sections on Chemistry and on the Botanical Sciences collaborated with the agriculturists in a discussion of improvement of soil structure at the Philadelphia Meeting of the Association in 1951. The most rapid advances in science are being made in research that involves the co-operation of specialists trained in several disciplines, and it is the aim of the American Association for the Advancement of Science to facilitate and accelerate developments of this kind. Australians and Americans share a common interest in agricultural progress, and it is hoped that the AAAS may serve, not only to bring the sciences together, but also to further co-operation among the scientists of countries that are widely separated in space but closely bound in spirit.

HOWARD A. MEYERHOFF,
Administrative Secretary.

TECHNICAL PAPERS

THE EFFECT OF NITROGEN ON THE YIELD, NITROGEN CONTENT, AND BAKING QUALITY OF WHEAT GROWN ON THE DARLING DOWNS, QUEENSLAND

By W. J. BISSETT and C. S. ANDREW

Summary

In a field experiment to test the effect of nitrogen and sulphur on wheat grown on a heavy black soil on the Darling Downs, a marked improvement in yield and quality of grain resulted from the application of nitrogen in the form of ammonium ion. A very striking correlation between added nitrogen and nitrogen content of grain, incidence of mottling, and baking quality was obtained. There was no response to sulphur or to potassium.

Introduction

In the course of pasture investigations at the Cooper Laboratory, Lawes, during the period 1950-51, it was found that three gramineous species (*Paspalum scrobiculatum, Setaria italica* and *Avena sativa*), when grown on a heavy black clay soil from Brookstead on the Darling Downs, gave large responses to combined applications of nitrogen and sulphur under glasshouse conditions.

The influence of nitrogen and sulphur on wheat yields and quality was examined under field conditions in 1951. The experiment was located at Pittsworth on soil as described hereunder (Beckmann and Thompson, unpublished data).

Soil (Type R1).

0 in. very dark grey brown, granular, medium to heavy clay.

2 in. very dark grey brown and very dark brown, nutty, heavy clay.

15 in. mottled dark grey brown, dark brown, odd dark yellow grey brown, heavy clay with weathered basaltic fragments.

20 in. very weathered basalt.

24 in. non-passable.

Experimental

The treatments were as follows:—

1. Ammonium sulphate—3 cwt./ac.
2. Ammonium chloride—2.43 cwt./ac.
3. Ammonium chloride+sulphur—2.43 cwt.+81.3 lb./ac.
4. Ammonium chloride+potassium sulphate—2.43 cwt.+3.95 cwt./ac.
5. Sulphur—81.3 lb./ac.
6. Potassium sulphate—3.95 cwt./ac.
7. Potassium chloride—3.38 cwt./ac.
8. Control (no treatment).

The amounts of nitrogen and sulphur supplied were equivalent throughout (N = 69.2 lb./ac., S = 81.3 lb./ac.). Potassium was included as a carrier for the sulphate radical.

The treatments were replicated six times. Plot size was 40 x 15 lk. (0.006 ac.). The fertilizers were broadcast by hand two days before sowing, which was done on June 1. The variety of wheat used was Puora.

On November 7 the plots were harvested by cutting a strip 30 x 5 lk. from the centre of each plot with a motor scythe and the material brought to the laboratory for threshing and winnowing.

W. J. BISSETT, B.Sc.Agr., and C. S. ANDREW, B.Sc.Agr., are Research Officers of the Division of Plant Industry, C.S.I.R.O., Regional Plant and Soils Laboratory, Brisbane.

TABLE I

Effect of fertilizers on yield, bushel weight and 1,000-seed weight

Treatment	Yield (mean of 6 replicates) (lb./ac.)	Bushel weight (composite samples) (lb.)	Yield (mean of 6 replicates) (bushel/ac.)	1,000-seed weight (mean of 6 replicates) (grams)
Ammonium sulphate	678	68.5	9.9	32.05
Ammonium chloride	691	68.7	10.1	33.25
Ammonium chloride + sulphur	708	68.6	10.3	32.85
Ammonium chloride + potassium sulphate	691	68.6	10.1	32.93
Sulphur	488	68.5	7.1	33.63
Potassium sulphate	543	68.0	8.0	34.12
Potassium chloride	445	67.9	6.6	33.43
Control	525	68.0	7.7	34.32
Min. diffs. for significance—				
5% level	108			0.86
1% level	145			N.S.

Results

A uniform strike was obtained as a result of satisfactory planting rains. From mid-June onwards, however, conditions were very dry, and when inspected on August 16, the crop was showing signs of restricted growth. Fertilizer effects were very marked at this stage. In all plots which had received ammonium fertilizer the plants were larger than those of the controls, and of a healthy dark-green colour in contrast with a light yellowish-green. None of the other fertilizers showed any effect. Dry weather continued, and when inspected on September 18 the crop showed signs of failure. However, it was saved by three falls of rain totalling 196 points between September 19 and October 13. The effect of the ammonium fertilizers was maintained throughout the life of the plants. At time of harvesting the plants of the ammonium-treated plots were taller than those of the other plots, and, in addition, had more tillers and larger ears.

Yields, bushel weights, and 1,000-seed weights for the different treatments are shown in Table I.

All yields were low owing to the abnormally dry season. The higher yields from the ammonium treatments were due to a greater number of grains. This is in accord with the fact that more tillers and larger ears were observed on these plants in the field.

The total nitrogen percentage of duplicate samples was determined by the Kjeldahl method. These, together with the calculated total yield of grain nitrogen per acre, are shown in Table II.

TABLE II

Effect of fertilizer on percentage and yield of nitrogen in wheat grain (mean of 6 replicates)

Treatment	Percentage N	Yield of grain N per acre (lb.)
Ammonium sulphate	2.35	15.9
Ammonium chloride	2.25	15.5
Ammonium chloride + sulphur	2.25	15.9
Ammonium chloride + potassium sulphate ..	2.26	15.6
Sulphur	1.71	8.3
Potassium sulphate	1.68	9.1
Potassium chloride	1.71	7.6
Control (no treatment) ..	1.77	9.2
Min. diff. for significance—		
5% level	0.12	

There was a marked difference in the appearance of the grain from the two groups. That from the ammonium treatments consisted almost entirely of dark-brown, vitreous grains. That from the other group consisted mainly of pale coloured and mottled grains. In view of the results obtained above, baking quality tests were conducted. Representative farinograms and extensograms are shown in Figures 1 and 2.

A sample of grain from each plot was submitted to the State Wheat Board for grading. All samples were graded "Q1", thus showing that, according to the Wheat Board's standards, all the grain was of first quality. Miller's grading, based on visual assessment of the degree of mottling, was carried out by the Queensland Co-operative Milling Association Ltd. For ease of tabulation the different grades were given a numerical rating and the results are summarised in Table III.

TABLE III

Effect of fertilizers on mottling of wheat grain (mean of 6 replicates)

Treatment	Rating
Ammonium sulphate	2.0
Ammonium chloride	2.3
Ammonium chloride + sulphur	2.0
Ammonium chloride + potassium sulphate	2.0
Sulphur	5.0
Potassium sulphate	5.0
Potassium chloride	5.0
Control	4.7

Min. sig. diff.—5% level, 0.82.

Key to Ratings:

1. prime, no mottled grain;
2. very slightly mottled (up to 2½%);
3. slightly mottled (2½-5%);
4. mottled (20-50%) sufficiently to condemn for milling, but can be milled if diluted with a good quality wheat.
5. badly mottled (50-100%); useless for milling.

Of the 24 samples from the ammonium-treated plots, only two were mottled sufficiently to condemn them for milling.

Discussion

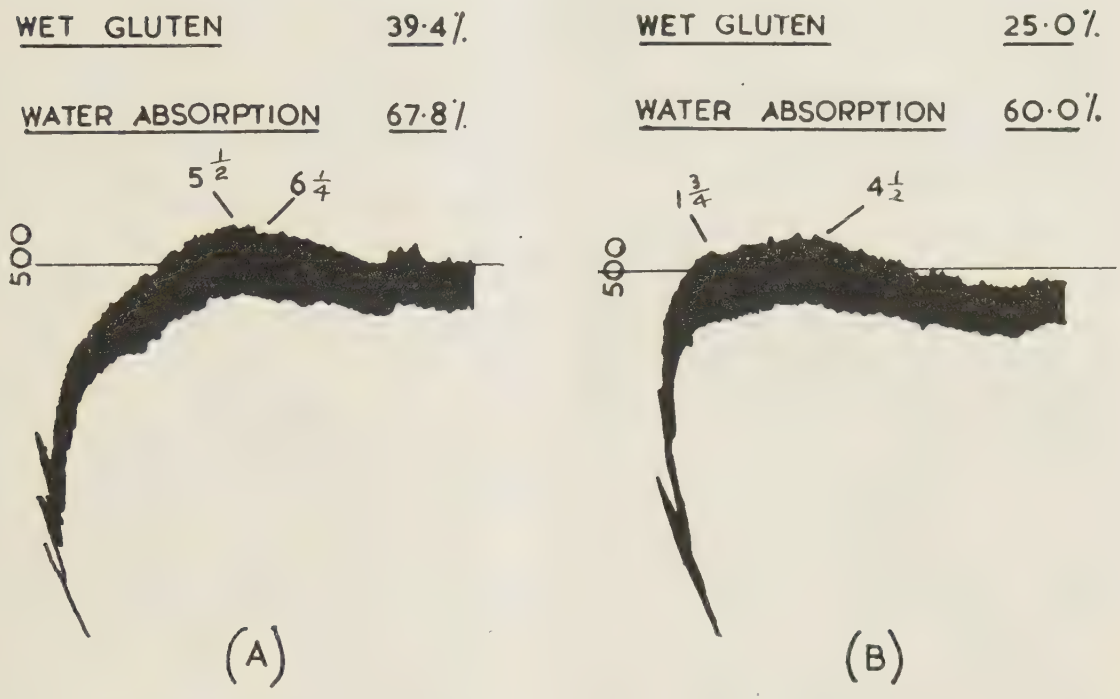
The effect of nitrogen on the protein content of wheat has been studied by many American investigators. The general result has been that the efficiency of applications of nitrogen depends on the lateness in the stage of plant development at which the fertilizer is applied. Early application gave increased vegetative growth with greater grain production and in some instances (depending on the variety) a decreased protein content (Gericke, 1927.) Long and Sherbakoff (1951) showed that baking quality as well as protein content of wheat is improved by late applications of nitrogenous fertilizer.

On the contrary, the results of this experiment show a large increase in both yield and nitrogen content from an application of nitrogen applied at sowing time. The heavy rate of application of nitrogen and the dry weather encountered during the later stages of growth allowed a sufficient supply of available nitrogen at the time of seed development. The fact that a linseed crop sown on the experimental area the following year showed a definite nitrogen response (denser growth and better colour) gives added weight to this explanation.

Although Australian workers have published information relating to mottling, there does not appear to be any conclusive evidence as to the exact nature of the cause. The 1950-51 Annual Report of the Department of Agriculture and Stock, Queensland, states that little headway has been made in determining why mottled

Figure 1.

Farinograms of flour from wheat grown with and without ammonium fertilizer on Darling Downs heavy black soil.



(A)—3 cwt. sulphate of ammonia per acre applied at sowing.

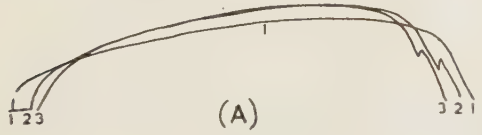
(B)—Untreated.

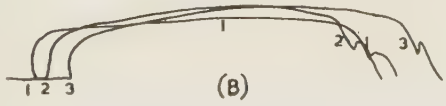
Figure 2.

Extensograms of flour from wheat grown with and without ammonium fertilizer on Darling Downs heavy black soil.

CURVE		1	2	3
TIME		45	90	135 mins.
EXTENSIBILITY	(E)	19·9	18·2	17·4 cms.
RESISTANCE TO EXTENSION	(R)	215	245	245 units (B.)
AREA	(A)	8·62	9·04	8·72 sq.ins.
	(R/E)	10·8	13·4	14·0

CURVE		1	2	3
TIME		45	90	135 mins
EXTENSIBILITY	(E)	14·4	13·3	15·0 cms.
RESISTANCE TO EXTENSION	(R)	150	175	178 units (B)
AREA	(A)	4·97	5·10	5·86 sq.ins.
	(R/E)	10·4	13·1	11·8





(A)—3 cwt. sulphate of ammonia per acre applied at sowing.

(B)—Untreated.

grain occurs, though it seems that the condition reflects the general level of soil fertility. It adds that mottled grain decreases progressively with lateness of application of nitrogen. Graham (1948) indicated that mottling, low protein crops, and lower yields were associated with depleted nitrogen conditions in the wheat areas of New South Wales, but stated that confirmation was required.

The information gained by other workers has for the most part dealt with only two aspects of this baffling problem of mottling: its cause, and its effect on baking quality. This paper attempts to correlate the four aspects—yield, nitrogen content of the grain, mottling and baking quality.

Conclusions

From the evidence presented in this paper the following conclusions are drawn, viz.:—

1. Available nitrogen is a limiting factor in the yield and quality of wheat grown on this soil.
2. Nitrogen content of the grain, baking quality of the flour, and mottling are correlated.

Acknowledgments

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References

Gericke, W. F. (1927).—Why applications of nitrogen to land may cause either increase or decrease in the protein content of wheat. *J. Agric. Res.* 35: 133-139.

Graham, S. C. (1948).—The loss of soil fertility in New South Wales as reflected by wheat quality. *J. Aust. Inst. Agric. Sci.* **14**: 194-195.

Long, O. H., and Sherbakoff, C. D. (1951).—Effect of nitrogen on yield and quality of wheat. *Agron. J.* **43**: 320-321.

Queensland Department of Agriculture and Stock (1951).—*Annual Report of the Department of Agriculture and Stock for the year* 1950-51. (p. 29).

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CONTROL OF STINKWORT BY HORMONE TYPE WEEDICIDES

By I. McL. EADIE

Summary

Various means of controlling Stinkwort are discussed.

A trial was made using the sodium salt and butyl ester of M.C.P.A., the ethyl ester of 2,4-D, the butyl ester of 2,4,5-T, and mixed butyl and ethyl esters of 2,4,5-T and 2,4-D applied as low volume sprays to young Stinkwort at 1 and 2 lb. of acid equivalent per acre with the addition of wetting agents. All treatments gave 99 per cent. kills. A later application showed that mature Stinkwort is harder to kill although the esters were more effective in reducing flowering and seed setting than sodium M.C.P.A.

Young Stinkwort can be killed by the ethyl ester 2,4-D or sodium salt of M.C.P.A. applied at the rate of 1 lb. of acid equivalent per acre for approximately £1 per acre. Results indicate that lower rates of application may give control when the weeds are treated in the correct stage.

Introduction

Stinkwort (*Inula graveolens*) is a summer growing annual. The sticky and odorous leaves will stain wool, but not seriously, and when eaten by stock cause meat and milk to become tainted. The weed is a danger to sheep in the flowering stage as the pappae cause an enteritis which can be fatal or predispose enterotoxaemia; vaccination is not recommended and sheep owners have to remove their sheep from Stinkwort before it flowers.

It is a weed which has adapted itself to a remarkable range of soils and climates; it is found at home growing in the high rainfall hills and valleys of Gippsland and again in the Mallee and semi-desert regions of South Australia and Victoria. Figure 1 shows an infestation typical of many thousands of acres of arable and grazing land in Victoria and South Australia.

I. McL. EADIE, B.Agr.Sc., is an officer of Imperial Chemical Industries, Melbourne.

Some farmers consider that it is quite useful fodder and that it helps to stabilize the Mallee sandhills. There is little doubt, however, that in the Mallee, undersown barrel clover or lucerne would provide a better return where they can be established, and Ryecorn appears to be a more lucrative and satisfactory method of holding the sandhills. Any virtues claimed for the weed are over-ruled by the fact that it has been declared a noxious weed within the State of Victoria.

Heavy grazing by locally-bred sheep will check the weed, but seeding is still prolific when they are removed as the flowering stages appear. Summer cultivation will control the weed but this wastes the stubble and may aggravate erosion on arable land. Hand pulling can be resorted to where the weeds are few and gloves should be worn to avoid the dermatitic hazard. Chemicals such as chlorates and the hormone-type weedicides will kill the weed but the cost of

Figure 1.
Showing typical infestation of arable land by Stinkwort.

treatment may be a limiting factor. A trial was laid down to confirm previous findings that 2 lb. of acid equivalent applied as the sodium or triethanolamine salts, or esters of *2,4-D and M.C.P.A. would kill young Stinkwort and to determine whether lower rates of application would give a more economical control but reduced kill.

Trial Procedure

The trial area, situated on a small spur of the Tallarook ranges above Trawool, was selected because the infestation was particularly heavy (up to 19-20 Stinkwort plants per sq. ft.), and growing on the same soil type, a granitic gravel. The inaccessible nature of the area made low volume spray equipment necessary. The Stinkwort infestation was very even and treatment made when practically all the weeds were between the seedling stage and 4 in. high.

A knapsack sprayer with attached 4-ft. hand boom applied 20 gal. of spray per acre through 4 flat fan Monarch type 0.25 nozzles when the operator walked at slightly less than 1½ m.p.h. The operator travelled 1/40-ac. plots (200 x 12.5 lk.) up and back twice to apply the required volume of spray and was guided by a centre string line knotted at 4 places so that he could be timed to cover the length of the plot in the correct number of seconds.

A check on the quantity of spray applied showed the biggest variation in output per plot (½ gal. per 1/40 ac.) was an excess of 2 fluid oz., which gave a 2½ per cent. error in applying the chemical. This error appeared to be due to variation of pressure and could be eliminated by inserting a pressure gauge between the pump and the 4-ft. boom.

Each of the 5 treatments applied at the rate of 1- and 2-lb. acid equivalents per ac., replicated twice, gave a total of 24 x 1/40-ac. plots, including 4 control plots.

A wetting agent was added to all treatments at the rate of 3 fluid oz. per 20 gal. of spray. All treatments were made on the one afternoon under similar conditions of temperature, humidity and light, the wind factor being negligible.

Assessment of the weed population before and after treatment was made by 20 throws with a 4-sq. ft. quadrat along the length of each plot. However, the kill obtained on all treated plots was far better than expected. As a result the quadrat method of estimating the weed population after treatment was quite inadequate, and it was decided to count weeds remaining on the treatment plots and to use the quadrat to assess only the control plots.

Results

The results of the trial are summarised in Table I.

These show that all five treatments at both rates of application gave a better than 99 per cent. kill.

Consideration of the Stinkwort plants remaining on the plots after treatment showed that the differences between the treatments were significant.

Figure 2 gives a visual indication of the marked results obtained.

Figure 2.
Showing unsprayed rows of flowering Stinkwort between treated plots.

*2,4-D—2,4-dichlorophenoxyacetic acid.
M.C.P.A.—2 methyl, 4 chlorophenoxyacetic acid.
2,4,5-T—2,4,5-trichlorophenoxyacetic acid.

TABLE I

Showing measure of control of Stinkwort (Inula graveolens) by five hormone-type weedicide treatments

Treatment Date—8/1/52	Percentage kill			Total weeds after treatment Date 14/2/52			Total weeds after treatment Date 20/3/52			Total weeds after treatment. Mean of both observations
	Concentration			Concentration			Concentration			
	1 lb.	2 lb.	Mean	1 lb.	2 lb.	Mean	1 lb.	2 lb.	Mean	
Na M.C.P.A.	99.48	99.85	99.66	43.5	14.0	28.8	63.0	16.5	39.8	34
Butyl M.C.P.A. ..	99.10	99.63	99.37	137.0	67.5	102.2	141.5	59.0	100.3	101
Ethyl 2,4-D	99.76	99.49	99.63	24.0	36.0	30.0	11.0	29.5	20.3	25
Esters 2,4-D/2,4,5-T	99.83	99.96	99.90	24.0	4.0	14.0	15.0	5.0	10.0	12
Butyl 2,4,5-T	99.02	99.25	99.13	96.0	77.0	86.5	57.5	12.0	34.8	61
Mean	99.44	99.64		64.9	39.7		57.6	24.4		Difference for significance— 5% level, 42 1% level, 58
Control			—16.28			14,282			14,282	

Discussion

The trial shows that Stinkwort can be killed in the young stages by a hormone type weedicide applied at the rate of 1 lb. of acid equivalent per acre as a low-volume spray application.

Although the mixed esters of 2,4-D and 2,4,5-T gave the best kill it was not significantly better than the ester of 2,4-D or sodium M.C.P.A. Since 2,4,5-T is a more expensive chemical its use either alone or in combination with 2,4-D cannot be recommended. The most economical kill was given by the sodium M.C.P.A., however, the ester 2,4-D is only slightly more expensive and if spraying should be delayed until the Stinkwort has reached a more mature and therefore resistant stage then the ester of 2,4-D should be applied. Assessment of controls given by similar treatments applied during March, when the Stinkwort was in the pre-flowering stages, was found to be most difficult. It was impossible to distinguish between dead and dying plants or to determine plants which had been able to flower and set seed and those which had not, or again, those which had been able to set only a limited number of seeds. Observations indicated that the ester preparations caused the greatest inhibition of flowering whilst the sodium M.C.P.A. was relatively ineffective. The control given by late sprays applied to the pre-flowering stage was not comparable with the early sprays when the Stinkwort was less than 4 in. high.

Acknowledgements

The author is indebted to Miss N. Ditchbourne of the section of Mathematical Statistics, C.S.I.R.O., for assistance with the statistical analysis of experimental results, and to I.C.I.A.N.Z. for the time and facilities needed to conduct the trial.

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TECHNICAL NOTES

A NOTE ON ALLEGED RUNS OF DRY AND WET YEARS

It is widely believed that rainfall in Australia is not only erratic but is also liable to come in long runs, with four or five years at a time above or below normal. Perhaps this belief has weakened recently in the eastern sub-tropics at least, where the wettest year on record (1950) was followed by the driest (1951); but in any case it has no substance, as will be shown.

We may test the belief in the simplest way, by noting whether the year's rain is above or below the median, and applying the theory of tossing a penny. If we call a "run" any succession of one or more of one kind, then half of all "runs" will be single. (If we have just thrown a head, it is an even chance that the next will be a tail—that is, that the "run" will be finished). Similarly, half of the remaining runs will be pairs; having two heads in succession it is an even chance that this run will be ended by a tail. So too, half of the remaining runs will be groups of three, and so on, ad infinitum. So half the runs are single, one-quarter are pairs, one-eighth are trios, etc. The numbers of throws belonging to each group are then given by 1/2, 2/4, 3/8, 4/16, 5/32, etc.; the sum of this infinite series of fractions being 2. Thus, 1/4 of all throws are single, 2/8 are in pairs, 3/16 are in trios, etc.

If the rainfall is completely at random, with annual totals shaken from a pepper-pot, we should expect that in 64 years there would be 16 cases of a dry between two wets, or a wet between two dries; 8 cases (16 years) of two wet or two dries running; 4 cases (12 years) of three wets or three dries; 2 cases (8 years) of runs of four; 1 case (5 years) of runs of five. The remaining 7 out of the 64 represent the fractional chances of even longer runs than 5.

This simple formula applies to an infinitely long series. It cannot work exactly for a finite one, but the error is small if we have enough years. In 40 years (say) cut from an infinite series, there might well be a long run either of wets or of dries, since wets and dries need not add up to 20 each; but when we have a *total* of 40 years then wets must equal dries, and there is, therefore, less chance of long runs.

Without going into the detailed theory, it appears that for 40 years, singles and pairs should make up 27 per cent. each, not 25, while the spells of 5, 6 and 7 years are each nearly 1 per cent. below the value of the simple formula. (Longer spells are diminished relatively more, but they make up little of the total). For a period of 80 years, the departures from simple theory are only half as great as this. The theory can be simply checked with a pack of cards, in which, after a random shuffle, we can count the runs of reds and blacks.

When 100 Australian districts are tested, for periods ranging from 38 to 80 years, the following facts emerge:—

(1) The frequency of spells of 3 years or more is just what would occur in the ideal distribution. Ideally, 46 per cent. of all years (see above) should fall into such spells; in fact, the average for Australia is 45 per cent. There are also fewer than the ideal figure of 27 per cent. of years falling into spells of 4 years or more.

(2) Spells of 2 years at a time average 34 per cent. of all years against the

expected 27 per cent. About half of this excess is gained at the expense of the longer spells, and half at the expense of single years, which do not reach their expected 27 per cent.

(3) These peculiarities are especially marked in the sub-tropics of eastern Australia, where many 80-year records have been used and many districts have over 40 per cent. of 2-year spells. Figures for Western Australia, however, are close to the theoretical.

Some of these departures from ideal values occur oftener than would be expected by chance; however, the major conclusion to be drawn is that spells of 3 years or more are no more frequent than should be expected by chance, while the apparent tendency towards 2-year spells may be left for more expert study.

The same technique can be used for months as for years, marking each month as "wet" or "dry" according to whether its rain is above or below its median. When this is done, many places still give the same numbers of runs as might be expected from tossing a penny; these include Swan Hill, Melbourne, Orbost, Wagga, and Warwick. In contrast, Euroa (in north-east Victoria, with a marked winter maximum) is consistently "spelly"; spells of 5, 6 or 7 months continuously wet or dry are twice as common as would be expected, while spells of just 2 months are only two-thirds as common as expected. In other words, if a spell lasts as long as 2 months it tends to persist for at least 5 months. Such persistence has been known to meteorologists for many years, but it does not last very long, and apparently is only important in a few kinds of climate.

G. W. LEEPER.
School of Agriculture,
University of Melbourne.

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BOOK REVIEW—

THE ASSOCIATION OF ANTS WITH APHIDS AND COCCIDS—By J. E. G. NIXON

(Commonwealth Institute of Entomology, 1951, *pp.* 36. *Obtainable from the C.A.B. Liaison Officer at* 314 *Albert Street, East Melbourne, C.2., Victoria. Price* 6/3d).

Nixon's review of the literature on the association of ants with aphids and coccids has focussed attention on a fascinating and important field of study. The behaviour of ants and their attendance on various Homopterous insects have for long been subjects of popular speculation and imagination and a critical review of this kind is long overdue. In frankly criticising the older subjective and picturesque interpretations of this association, Nixon has raised reasonable doubts in the reader's mind about the reliability of the commonly held views not supported by factual evidence.

It is usually accepted, for example, that a complex bond unites the lives of Homopterous insects and their attendant ants resulting in mutual benefit. This bond has been variously described as symbiotic or mutualistic. However, it appears from more recent work that a much simpler explanation is likely to be more accurate. It is submitted that the attendant ant is both repelled by the aphids it attends and attracted by the honeydew they excrete. In removing a waste product the ant is principally a scavenger. It seems clear also that Homopterous insects are not protected simply because they yield a valuable ant food, though many species do, in fact, receive a certain accidental protection from their natural enemies while ants are in attendance.

Although Australia has a rich native ant fauna, and such renowned pests as the Argentine Ant *Iridomyrmex humilis* and *Pheidole megacephala* have been introduced, the review shows there is a remarkable dearth of published work on the association of ants with aphids and coccids in this country. Moreover, there are numerous references in overseas journals to the alarming way in which the Argentine ant fosters many serious coccid and aphid pests of citrus and other crops. It is indeed disturbing to speculate on the probable effect this ant might have on our many scale and aphid pests should it succeed in spreading from our infested urban areas to nearby agricultural land.

The *Psyllidae* almost completely replace the *Aphididae* in the Australian fauna and there is a close association of ants with the many species secreting honeydew. As several species of Psyllids are important forest pests it is to be hoped that Nixon's review will also stimulate research of a critical character on this quite important association.

SOIL MONOLITHS—SEEING THE SOIL PROFILE

Introduction

As a means of seeing the nature of and understanding the principle of the soil profile, the soil monolith comes second only to field inspection. But some aspects of even field inspection can be surpassed by soil monoliths, namely, the comparison of two profiles. A much more reliable comparison is possible between two monoliths standing side by side than between two soil pits separated by time and space with only the human senses to bridge the gap.

Many attempts have been made previously to emulate the soil profile, but none can compare with the soil monolith. Such examples as profile diagrams, photographs, miniature profiles made from ground soil glued to cardboard, samples of each horizon packed into a sequence of small boxes, complete profiles packed into glass cylinders and so on have had and still have their uses, but are far from ideal. The prime merit of the soil monolith is that it is an actual profile as it existed *in situ;* a particular individual of the population comprising its soil type. The viewer is given to remember some profile which does in fact exist, rather than something he has had to imagine and build up from one of these other incomplete representations of a soil.

Figure 1.
The pit-face cut to leave a projecting column of soil.

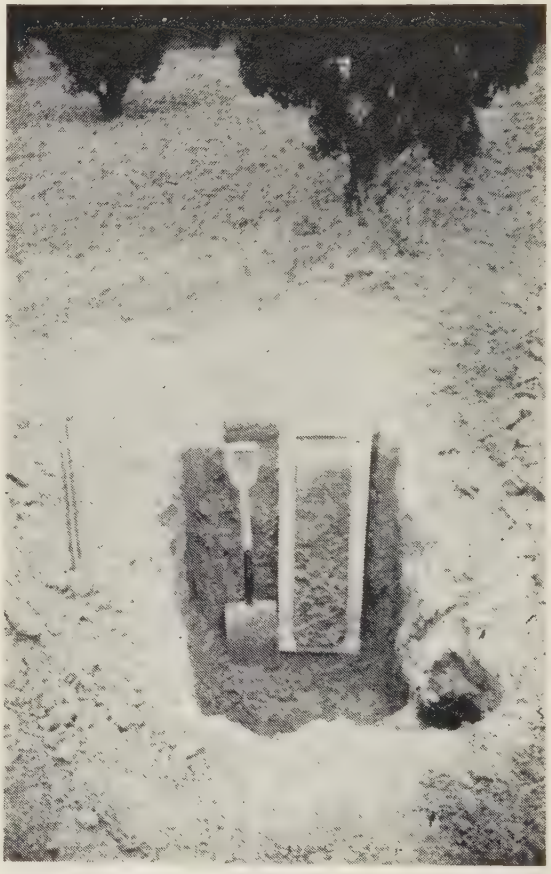

Figure 2.
The column enclosed in an angle iron frame. The wooden back has been left off for clarity.

Thus it can be seen that by taking a modal profile as a monolith, a soil type may be excellently demonstrated visually both for comparison and instruction.

History

Interest in soil monoliths was first aroused by the Russian soils sent to the Exposition universelle in Paris in 1889 (Demolon, 1949). This interest has increased as more suitable mounting materials have become known and available. Thus some of the methods used have been to collect the soil mass in a glass-fronted box, to use deliquescent substances to preserve wetted-up colours, to preserve the mass with glue or photographic film lacquer or cellulose acetate or nitrate in acetone, clear lacquer, collodion varnish or most recently, one of the transparent plastic resins.

The first monoliths of the CSIRO Division of Soils, Adelaide, were made in 1951 following the instructions of Berger and Muckenhirn (1945) and using vinylite resin. A full account of the modified methods adopted, the equipment used and also detailed instructions for preparing monoliths is given by Wells (1953).

Preparation

It has been found most convenient to take monoliths of soils from the pits already dug for sampling. The pit-face is cut back down each side to leave a column 4 ft. long and 8 in. wide projecting 2 in. out into the pit. This column is then enclosed in an angle-iron frame (essentially a false-bottomed box) to keep it together while being dug out. In the laboratory this 2 in. thick column is stuck to a mounting board with vinylite and allowed to dry to a suitable moisture content for picking down.

The picking-down stage is one of the most critical in the preparation of the monolith. The thickness of the column is reduced to about 1 in. by picking out individual aggregates. The result is a close approximation to a perfect cleavage face and very plainly demonstrates the structure of the soil. After being left to completely air-dry, the monolith is gently sprayed with vinylite both to bind it together and to protect it from external agencies.

Figure 3.
A collection of completed monoliths at the Waite Institute.

The result is an easily portable, lasting example of a soil type as well as exhibiting its natural features including wetted-up colours.

Display

For display the monoliths are assembled in glass-fronted cases to protect them from laboratory dust which appreciably distorts colours and general

appearances. McClure and Converse (1940) recommend that lighting should be by 36 in. long, 30W tubular fluorescent daylight lamp. Lynd (1950) has described useful portable display racks for use with students. Various amounts of data concerning the soil may be pasted to the mounting board.

Statistics

For most of the time only one person is required in the preparation of monoliths, though in two of the stages it is safer to have help from a second person. The time required to prepare a monolith varies greatly with each case. It is important to realise that it is an intermittent task; the sum of hours spent in preparation is not so great, but it is spread over several weeks and months. As a very rough guide some likely working times are given:—

making-up solutions	2 hr.;
taking monolith	2 hr.;
trimming and mounting ..	1½ hr.;
picking down	6–12 hr.;
impregnating	½ hr.;
finishing	4 hr.

It should be noted that travelling time and time to dig and fill in the pit are not included.

The material used in making 12 monoliths is approximately:—

Vinylite—5 litres;
Acetone—30 litres;
Methyl isobutylketone—1 litre.

References

Berger, K. M., and Muckenhirn, R. J. (1945).—"Soil profiles of natural appearance mounted with vinylite resin." *Proc. Soil Sci. Soc. Amer.* **10**: 368-370.

Demolon, Albert (1949).—"La Genetique des Sols." Presses Universitaires de France, Paris.

Lynd, J. Q. (1950).—"Soil monolith displays." *Agron. J.*, **42**: 574-575.

McClure, G. M., and Converse, C. D. (1940).—"A method for taking and mounting monolithic soil profile samples." *Proc. Soil Sci. Soc. Amer.*, **4**: 120-121.

Wells, C. B. (1953).—"Soil monoliths: their preparation and preservation under southern Australian conditions." C.S.I.R.O. Div. Soils Tech. Mem. 8/53.

C. B. WELLS.

Division of Soils,
C.S.I.R.O.,
Adelaide.

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ERRATUM

Volume 18, No. 4, December, 1952

In the article by L. G. Vallance, "The sugar industry in Australia," line 28, column 1, page 214, and the following table should be altered to read "average yields of sugar for the following years at ten-yearly periods:—

1880	— 1.27 tons
1890	— 1.69 tons
1900	— 1.28 tons
1910	— 2.23 tons
1920	— 1.88 tons
1930	— 2.33 tons
1940	— 2.88 tons
1950	— 3.42 tons

SOILS OFFICER, DEPARTMENT OF AGRICULTURE, VICTORIA

Applications, addressed to the Secretary to the Public Service Board, Public Offices, Treasury Place, Melbourne, C.2., Victoria, and accompanied by evidence of experience and qualifications and a statement of date and place of birth, are invited for the abovementioned position up to Wednesday, the 15th April, 1953.

Yearly Salary: £1,126 minimum; £1,178 maximum. (including cost of living adjustment).

Duties: Under general direction, to control soil surveying parties and to investigate soil problems in the field and laboratory.

Qualifications: To hold a Degree in Science or Agricultural Science, or equivalent qualifications, and to have had considerable experience in soil chemistry and in soil surveying.

COUNCIL PROCEEDINGS

Meetings of Proxy Council were held on December 15th, 1952, and February 16, 1953, at C.S.I.R.O., Canberra.

Items of interest are as follows:—

Agricultural Engineering

Following the address by *Mr. G. H. Vasey* at the 19th General Meeting, a rich diversity of comments has been received from branches. These substantially covered the field of ideas out of which the earlier reports developed. Proxy Council commended the following points for consideration by the incoming Council:—

(a) there is abundant evidence of the need for new or improved types of machines and other equipment.

(b) there is a case for research work being done by a central body or engineering and agricultural faculties in association with an agricultural college.

(c) there is little evidence at present on whether a sufficient demand exists for agricultural engineering to justify commencing a course but that an effort be made to obtain evidence on this vital point.

Mr. G. H. Vasey will contribute articles to the Journal on the role of agricultural engineering and the position overseas.

Rural Extension Services

The sub-committee appointed by the 19th General Meeting to lead the study on ideals in pre- and in-service training in extension is expected to make a report in advance of next meeting of Council.

Text Book

Mr. P. J. Skerman has reported progress in securing conveners in several branches and should soon be in a position to assess the prospects for carrying through the proposal of an A.I.A.S. sponsored text book at the farmer or agricultural college level.

A.N.Z.A.A.S.

The Institute has approached the Executive of A.N.Z.A.A.S with the proposal that a joint session of the A.I.A.S. with Section K be held at the next meeting and a further proposal that the support of F.A.O. be sought to bring to A.N.Z.A.A.S. a prominent member of its organization. These matters are still being considered.

Affiliate Membership

Following a demand from the Queensland delegate a postal vote on the amendments to create a class of affiliates was held with the following result.

Branch	For	Against	Informal	Total
Victoria	45	55	—	100
New South Wales	33	52	1	86
South Australia .	7	39	—	46
Tasmania	6	13	—	19
Queensland	5	37	—	42
Western Australia	10	33	1	44
Australian Capital Territory	20	14	—	34
TOTAL ..	126	243	2	371

This vote thus reversed unequivocally the decision of the 19th General Meeting.

Election of President

It was with pleasure that the Council announced the election of *Dr. A. R. Callaghan* as President for 1953.

Australian Medal of Agricultural Science

Five nominations were received for the medal, the closely contested ballot being won by *D. S. Riceman* who was nominated for his outstanding work on soil amendments in deficiency areas in South Australia. The medal will be presented at the Annual General Meeting to be held in Adelaide on March 23.

Honorary Life Membership

Dr. G. L. Sutton has been elected to honorary life membership in recognition of his contributions to Australian agriculture in breeding high production wheats and of his progressive administration as Director of Agriculture in Western Australia. The honour will be conferred at the Annual General Meeting.

Membership

128th Meeting of Council

Admissions

With the recommendation of the branch submitting the application and the Qualifications Committee the following applications were approved for **Corporate Membership**—

Byrne, P. N.	South Australia
Clarke, A. L.	„
Passey, R. F.	„
McLeod, N. D.	New South Wales
McPhillips, J.	„
Zenter, H.	„
Sykes, R. C.	Tasmania
Bailey, E. T.	Western Australia

The following corporate members were accepted for **Emeritus Membership**—

Watt, R. D.	New South Wales
Johnstone, R. H.	Tasmania

Transfers

Wagner, V. J., New South Wales to Queensland
Tesch, J. E., Queensland to Victoria.
Carter, M. V., South Australia to Australian Capital Territory.
Possingham, J. V., South Australia to Australian Capital Territory.

Resignation

Feilen, P. J. .. .. .. New South Wales

Death

Carne, W. M. .. .. .. New South Wales

Corporate Termination

Doig, W. T. .. Australian Capital Territory

Cancellation of Student Membership

Byrne, P. N. .. .. .. South Australia
Clarke, A. L. .. .. .. „
Dann, P. R. .. .. New South Wales
Donald, N. D. .. .. .. „
Begley, L. .. .. „
Hall, B. J. .. .. „
Morgan, K. A. .. .. .. „
Marshall, K. C. .. .. .. „
McLeod, N. O. .. .. .. „
Passey, R. F. .. .. .. „

Subscriptions Waived

Williams, D. B., Australian Capital Territory, 1951.
Colwell, J. D., New South Wales, 1953, 1954.
Stack, M. J., New South Wales, 1952.
Gibbons, F. R., New South Wales, 1952, 1953.
Kingsland, A., New South Wales, 1950, 1951.
Bell, T. C., Victoria, 1952.
King, F. E., Victoria, 1952.
Walsh, J. C., Victoria, 1952.

129th Meeting of Council

Admissions

With the recommendation of the branch submitting the application and that of the Qualifications Committee the following applications were approved for **Corporate membership—**

Alexander, G. I. .. .. .. Queensland
Nott, A. L. .. .. Victoria
Fisher-Pollard, J. .. .. .. „
Sandiford, R. N. .. .. .. „

Acting on the recommendation of the Queensland Branch Mr. N. G. Dastane was admitted to **Student Membership.**

Corporate Resignations

Kerr, H. .. .. New South Wales
Gellatley, J. .. .. „
McGillivray, G. .. .. .. „
Wallace, C. R. .. .. .. „
Clayton, E. S. .. .. .. „

Corporate Terminations

McBride, G. .. .. Queensland
Denham, S. G. .. .. .. Victoria
Sluiter, G. B. .. .. .. „
Sutherland, J. R. .. .. .. New South Wales
Crofts, F. C. (Mrs.) .. „

Death

Clifton, A. R. C. .. .. Western Australia

Transfers

Marshall, I. D., Victoria to Australian Capital Territory.
Orr, J. S., Victoria to New South Wales.
Davies, J. G., Australian Capital Territory to Queensland.
Beale, C. I. A., Victoria to New South Wales.
Berry, D., Victoria to Tasmania.
Kentish, T. D., New South Wales to South Australia.
Ballard, L. A. T., South Australia to Australian Capital Territory.

Cancellation of Student Membership

Begg, J. E. .. .. New South Wales
Churchward, H. M. .. .. „
Crofts, F. C. .. .. .. „
Dotch, E. R. .. .. .. „
Ireland, G. R. .. .. .. „
Jackson, D. L. .. .. .. „
Madden, C. P. .. .. .. „
O'Brien T. A. .. .. „
Perry, T. R. .. .. „
Pulling, H. L. .. .. .. „
Purss, C. H. .. .. „
Scott, K. J. .. .. „
Woodhouse, L. R. .. .. „
Wright, P. .. .. „
Barker, J. S. F. .. .. Queensland
Brett, B. B. .. .. „
Brett, C. S. .. .. „
Edye, L. A. .. .. „
Egan, B. T. .. .. „
Grimmett, S. G. .. .. .. „
Henzell, E. .. .. „
Letchford, J. M. .. .. „
Logan, R. A. .. .. .. „
McCarthy, J. P. .. .. .. „
Southern, J. H. .. .. .. „
Talbot, R. J. .. .. „
Urquhart, C. N. .. .. „
Moore, D. G. .. .. .. Victoria

BRANCH NOTES

Australian Capital Territory

The Branch meeting held on 17th November was addressed by members of the Land Research and Regional Survey Section of CSIRO on the work of that section.

Mr. Christian referred to the regions that were selected for survey made to serve as a basis for future development of the North. These regions which total 250,000 sq. miles, were:

1) the Ord and Victoria River Regions
2) the Barkly Tableland Region
3) the Townsville-Bowen Region
4) the Ord and Victorian River Regions
5) a preliminary examination of areas of the Kimberleys.

As a follow-up to the survey the Land Research and Regional Survey Section has the responsibility for carrying out research in the regions surveyed. Two main research stations have been established, one at Katherine and the other in cooperation with the W.A. Government, on the Ord River in the Kimberleys.

The work of the section consists in mapping and classifying of the land and the making of some assessment of the potentialities and in so doing new ground has been broken in the description and methods of utilization based on economic factors.

Mr. G. A. Stewart spoke of the survey methods and the importance of the work of the geologist, geomorphologist and the ecologist in the task of assessing the potentialities for further development.

In mapping, large scale units had to be used and such compartments were given the name of Land Systems of which 37 were recognized in the Barkly Tableland region. Dry land agriculture may prove possible in the Darwin-Katherine area and rice growing may prove economic on poorly drained areas.

Mr. R. A. Perry, Ecologist, said that climate, especially rainfall, is the chief factor influencing distribution of the main types of vegetation. In the Barkly area two main types exist, namely grasslands and woodlands. Barley Mitchell grass is the dominant species and occurs on heavy clay soils from 12 inches rain in the South to 30 inches in the North. Northern Australia has been a pastoral area and the Barkly Tableland carries 10-20 cattle per square mile if adequately watered. Near the coast where the vegetation is mainly quick maturing *Sorghum* species, the carrying capacity is much lower because of the low nutritive level of the herbage.

Work is being carried out at the Kimberley Research Station on some of the native species of legumes which are needed to improve the quality of the pastures. Mr. R. O. Slatyer outlined the climatological approach to the problem of the assessment of land use potential of the various regions. Rainfall has been found to be the dominant factor related to plant growth and a set of arbitrary criteria based on response of species to rainfall has been developed.

At Katherine and Kimberley Research Stations a close study is being made of climate in relation to the growth of mature and introduced species in order to modify existing criteria or develop new ones.

Dr. E. Phillis in speaking of the research activities of the section, referred to the fact that there was no agricultural tradition in Australia on which to draw, and while this had been remedied in the South by bringing in skilled agriculturists, the problem of the North remained unsolved. Here we are faced with the problem of developing agriculture with very expensive labour compared with most other monsoonal countries.

Most tropical crops except maize can be grown both at Katherine and at the Ord River and the most successful have been *Sorghum*, peanuts, sunflower and safflower. Cotton is also showing great promise at Katherine but the crop will have to be planted and harvested mechanically. At the Ord River sugar cane with yields up to 80 tons per acre has been the outstanding species.

Dr. J. G. Davies addressed the Branch on 9th December, 1952, on Baluchistan, which country he visited as a member of an official F.A.O. team to advise on the economic development of the area.

Dr. Eric Ojala, Deputy Chairman of the Research Council of the South Pacific Commission, gave a most stimulating and informative address to a meeting of the Branch on 12th February, 1953, on the work of the South Pacific Commission. Dr. Ojala's address, which was heightened by a very fine series of colour slides, revealed the value and importance of the work of the Commission in seeking to meet the aspirations for a richer life of the peoples of the area. Particular reference was made to the appointment of specialists from all parts of the world to investigate major problems in relation to the medical, economic, agricultural and social fields and in the short space of five years some outstanding achievements are already evident.

New South Wales

At a general meeting, held in Science House on 30th October, 1952, an address was given by Dr. O. H. Frankel, Chief of the Division of Plant Industry, CSIRO.

Dr. Frankel at the beginning of his talk, which was entitled "Thoughts of a Newcomer," gave some of his main impressions of Australian agriculture on his arrival from New Zealand. The vastness of Australia, the amount of unexploited agricultural land and the magnitude of the problems were features which impressed him as one used to a small country.

Since the war, although the population has increased, Australia's agricultural production has increased only slightly and exports, except for wool, have decreased or remained stationary. In many overseas countries, however, where the potentialities have been exploited to a much greater extent, steady increases are being maintained.

Drawing a contrast between New Zealand and Australia, Dr. Frankel said that there were relatively few problem soils in New Zealand and the rainfall is uniform in distribution. The European migrants originally brought with them plants from which suitable strains developed.

In Australia the position is quite different. The extremes of climate and soil have made the establishment of a successful agricultural flora very difficult in many regions and there are large areas for which suitable plants have not yet been found. In New Zealand, agricultural practices could be carried on with relatively little alteration. The population is more evenly distributed and the potentialities of the country much better known than in Australia. The scope for improvement, for example, in increasing the amount of improved pastures, is limited in New Zealand whereas in Australia the position is quite different.

The agricultural research services of the two countries show some differences. In New Zealand the work is carried out entirely by the DSIR and the Department of Agriculture, both of which are responsible to the one Government. The division of work is clear cut, sometimes illogical, but workable. The DSIR handles the soil and plant work and the Department of Agriculture the animal work. This contrasts with the complicated situation in Australia, where the CSIRO, the State Departments of Agriculture and the Universities are all concerned. It is difficult to avoid overlapping and to obtain co-operation. It is impossible to have the work divided on a clearly defined basis. The abilities and interests of workers should be given greater attention when deciding how and where a particular job of research should be done. There should be more contact between all bodies concerned.

Dr. Frankel went on to point out that the expenditure on agricultural research in Australia is very small compared with that in the United States, Great Britain and New Zealand, particularly when it is considered that countries such as New Zealand have reached a stage where there is less and less return from research. Increased expenditure should bring substantial returns in Australia, for the ratio of present production to that possible with known methods must be very low.

There are big differences in the relative numbers of extension workers between New Zealand and Australia. In New South Wales, thirty-five men have to cope with areas far beyond the size that can be effectively handled. There is no doubt that increased extension work would result in greater financial returns.

In conclusion, the speaker pointed out the tendency for university students to drift away from biological and agricultural sciences. There is little glamour in these fields and the number of agricultural graduates is dropping at a time when agricultural research should be stimulated.

Dr. Frankel's talk was followed by an active discussion in which many members and visitors participated.

Queensland

At the October meeting, the Foundation President of the Queensland Branch (Mr. J. K. Murray) delivered an address on the development of the Territory of Papua-New Guinea, an area which was under his administration from 1945 to 1952. The Territory of New Guinea is administered by Australia under the surveillance of the United Nations Trusteeship Council, and its obligations under the trust are to consider the interests of the inhabitants as paramount, to look after the welfare of the native people and see to their social, economic and political development, and to develop the natural resources of the territory. For administrative purposes, Papua has been linked with the trust territory of New Guinea.

Mr. Murray explained some of the difficulties inherent in developing the people and the country—difficulties of race, language and customs. He stated that the area could produce the whole of the tropical ingredients that are missing from the Australian economy, but the potentialities could not be realised unless a market and an adequate price were assured and money was made available for the necessary capital works.

The November meeting was the annual Branch Prize Meeting, at which three papers selected for their merit from thirteen submitted by students were summarized by their authors. The prize was won by Mr. S. G. Grimmett, with Messrs. J. G. Morris and D. S. Teakle as runners-up.

Mr. Grimmett's paper dealt with an experiment designed to determine whether DDT or some other constituent of DDT sprays is responsible for the harmful effects sometimes observed from DDT spraying. The effects of various preparations on the growth of tomato seedlings were measured, and the author reached the conclusion that some proprietary DDT preparations contain an ingredient or ingredients other than DDT which are deleterious to tomato plants.

Mr. Morris described a trial in which the composition of milk from cows grazed on oats was studied. He obtained no evidence that grazing oats decreased the fat content of milk as reported by various authors.

Mr. Teakle's paper concerned an ecological study of powdery mildews occurring in Queensland.

South Australia

The probable relationship between cobalt and Vitamin B12 in animal nutrition was explained to a meeting of the Branch on November 28 by the Chief of the CSIRO Division of Biochemistry and General Nutrition (Mr. H. R. Marston).

Cobalt had been shown to be necessary in ruminent nutrition in 1934, following work with sheep on coastal soils in SA, Mr. Marston said. But its connection with B12 had not been suspected until 1946, when it was shown that the anti-pernicious anaemia factor — subsequently isolated as B12—contained comparatively large amounts of cobalt.

Since then, work at the Division of Biochemistry and General Nutrition laboratories had shown that cobalt was required for the synthesis of B12 in the animal body. Ruminents required comparatively large amounts of B12 and, consequently, large amounts of cobalt. The whole effects of supplying cobalt to a deficient animal could be simulated by treating the animal with large amounts of B12.

The full chemical formula of Vitamin B12 had not yet been solved, Mr. Marston said, but several teams of scientists in other parts of the world were working on it and making progress.

Mr. Marston also explained how it had been shown that Phalaris staggers, which affected many flocks in the South-East of SA last season, could be prevented by dosing the animals with cobalt.

Tasmania

The 55th general meeting of the branch held on 17th November, 1952, took the form of a business meeting. A sub-committee was set up to determine what use could be made of the information obtained at previous general meetings on the general theme of increased food production.

Victoria

On 29th October, 1952 a meeting of the Branch was addressed by Dr. J. K. Basu, on Agricultural Research in Bombay State. He discussed the problems faced by the Department of Agriculture and the difficulty of reconciling the urgent need for increasing food production, particularly in the form of cereals, with the necessity of pursuing methods to counteract the serious inroads of soil erosion and soil deterioration. He described methods by which agricultural production is being improved, including the reclamation of saline and alkaline soils, extension of irrigation, use of crop rotations and contour strip-cropping techniques, and investigations of fertilizer treatments for soils.

The end-of-year "Garden Party," which has become a regular function, was held, on account of inclement weather, in the School of Agriculture on 5th December. New graduates were entertained and welcomed and members and their guests passed a convivial evening.

The Salaries and Status Sub-Committee of the Branch took the initiative of convening, in December, a meeting of representatives of all professional organisations who have members in the Victorian Public Service. Following this initial meeting, discussions are being continued on possible ways and means of achieving better recognition of professional officers.

PERSONAL NOTES

Australian Capital Territory

Mr. J. G. Crawford, Secretary of the Department of Commerce and Agriculture recently returned from London where he had attended the Commonwealth Economic Conference as adviser to the Minister for Commerce and Agriculture, the Hon. J. McEwen.

Mr. K. R. Norris, Senior Research Officer, Division of Entomology CSIRO will transfer from Canberra to Brisbane during the winter of 1953 to take up field studies on the influence of time of dipping on the control of cattle tick.

New South Wales

Dr. N. H. White, Senior Lecturer in Agricultural Botany at the University of Sydney, recently returned after an absence of six months in the United Kingdom, Europe and America. During this time he visited many of the leading research and teaching centres in the field of plant pathology.

Mr. E. G. Hall, Senior Research Officer of the Division of Food Preservation and Transport, CSIRO recently returned to Australia. Last year he spent some months in England reporting on the out-turn of Australian fruit shipments for the Department of Commerce and Agriculture. After completing this work he visited centres of fruit storage research in Europe, Canada and the U.S.A.

Mr. E. J. Mason, formerly Entomologist with the N.S.W. Department of Agriculture, is now fruit-growing at Leeton, N.S.W.

Two new changes in senior positions in the Entomology Branch of the Department of Agriculture, have been announced. *Mr. S. L. Allman* has been appointed Chief Entomologist and *Mr. P. C. Hely* has been transferred from the Gosford Citrus Research Station to the position of Senior Entomologist.

Queensland

Mr. G. H. Allen, has been appointed Agronomist in the Regional Experiment Stations Branch of the Department of Agriculture and Stock.

Mr. S. G. Burns, has resigned as Agronomist in the Department of Agriculture and Stock to accept a position in New South Wales.

Mr. A. M. Evans, of the Australian Broadcasting Commission, has been transferred from Brisbane to Toowoomba, where he is Regional Rural Officer.

South Australia

Mr. M. V. Carter, formerly of the CSIRO Division of Plant Industry at Canberra, has joined the Plant Pathology section at the Waite Agricultural Research Institute and will work as a Gummosis investigator.

Mr. A. W. Moore, of the Soil Conservation Branch, Department of Agriculture will leave shortly to take up a Research Assistantship in the Department of Agronomy, Nebraska Univ. Lincoln.

Mr. J. S. Russell, of the Soil Conservation Branch has completed an M.S. at the Nebraska University and has been granted an extension of his research assistantship to complete work for a Ph.D.

Mr. P. McK. Barrow has taken up headquarters at Jamestown as Soil Conservation Officer for the mid-north.

Tasmania

Branch numbers have now risen to 42 with the admission of *Mr. J. Cerny*, Division of Plant Industry, CSIRO and *Mr. R. Sykes*, Department of Agriculture. *Mr. D. Berry* has been gained by transfer from Victoria.

Mr. F. H. Johnstone, has become the branch's first emeritus member of the institute. *Mr. Johnstone*, who was a foundation member of the branch, was formerly Government Analyst in Tasmania.

Victoria

Mr. J. E. Tesch, has transferred from the Queensland Branch to becomes Plant Superintendent of Imperial Chemical Industries' DDT Plant at Yarraville. As Production Manager of North Queensland Food Products, Townsville, he was formerly concerned with production of deep-frozen foods.

Mr. D. Berry, formerly in the Soil Conservation Authority, is now Sales Manager for superphosphate and Assistant to the Agricultural Adviser with Electrolytic Zinc in Tasmania.

Mr. I. D. Marshall, has moved from the Hall Institute for Medical Research to the Department of Microbiology at the National University.

Mr. J. S. Orr, of Imperial Chemical Industries, has moved to Sydney to the position of Sales Manager for agricultural chemicals. On account of this transfer he has been obliged to resign as Business Manager of the *Journal*.

Mr. C. G. Scarff, is now Service Manager for Houghton and Byrne Pty. Ltd., Pest Destroyers.

Mr. K. Loftus Hills, formerly in the Division of Plant Industry, CSIRO, and representative of the Victorian Branch on Proxy Council in Canberra, is now in the Agricultural Research Liaison Section in Melbourne.

Mr. R. A. Van Baer, entomologist in the Biological Branch of the Department of Agriculture, is making a trip to England and the Continent for a period of 12 months.

BOOK REVIEW

MANAGEMENT AND CONSERVATION OF VEGETATION IN AFRICA

(Commonwealth Bureau of Pastures and Field Crops Bulletin No. 41, 1951, *pp.* 96. *Obtainable from the C.A.B. Liaison Officer at* 314 *Albert Street, East Melbourne, C.*2. *Price* 13/2d.*).*

This bulletin is a symposium dealing with South Africa, East Africa, Tanganyika Territory, Sierra Leone, Nigeria, Anglo-Egyptian Sudan and the Gold Coast.

Each article excepting the one on the Anglo-Egyptian Sudan has been written by an experienced scientific worker who has specialised in ecology and land use and each draws attention to the problems arising from the exploitation of agricultural and pastoral lands. There is, in each case, emphasis placed on the need to understand the ecological relationships of the plant community, if the effects of climate and of the human and animal population are to be controlled.

J. D. Scott refers to a reduction due to soil erosion of 25 per cent. in the agricultural productivity of the Union of South Africa within 25 years.

The major factors were indiscriminate grazing, cutting of forest and bush for timber and fuel, repeated burning of the veldt and overcropping of agricultural lands leading to disaggregation of soil and depletion of plant nutrients. The same basic factors are recognised to be at work in each country. The problems in Africa are accentuated by the change in living conditions of the native populations, induced by European settlement, from nomadic and shifting cultivation to stationary agriculture, by greatly increased populations, both human and animal, resulting from improved medical and veterinary knowledge and hygiene and in Southern Africa by the significant difference in the effect on vegetation between the heavy intermittent grazing by game and the light but continuous stocking by the white pastoralist for his domestic animal.

This bulletin is of the greatest value to Australian research and extension workers in ecology and soil conservation and is particularly applicable in our sub-tropical and tropical areas. The articles by Keay on Nigeria and Deighton on Sierra Leone are of particular value to administrators and workers in New Guinea and Papua and in the reviewer's opinion provide a warning that changing the native agricultural regime from that of a shifting to a stationary agriculture is fraught with serious and far-reaching long-term consequences. The initial increase in population following adoption of stationary agriculture is rapidly followed by soil degradation and erosion, by shortage of food and even famine and the end point may easily be a far less virile and happy community than formerly.

Foggie and Hinds in their article on the Gold Coast sum up what is in fact the world problem. "Man as a biotic factor on the Gold Coast has assumed a greatly enhanced importance within comparatively recent years. How and at what level he will again come to terms with the soil and vegetation of his environment is a matter of speculation. It is obvious that methods must be devised to enable man to live not, as it were, parasitically on the land and vegetation, taking all and giving nothing, but that he should live in symbiosis with them, conserving and replenishing all that is good and useful."

This is a bulletin that should be widely read by Australians. The Bureau of Pastures and Field Crops has been responsible for yet another valuable Technical Bulletin.

NEWS ITEMS

Myxomatosis

Some publicity has been given to the fact that the virus of myxomatosis is showing signs of losing its killing power; landholders have been urged to make a special effort to consolidate the gains that the disease has brought to them by dealing with the surviving rabbit population by conventional methods, e.g. digging out, dogging and fumigating.

The facts behind the belief that there may only be a short time left for the exploitation of the full benefits of myxomatosis are briefly as follows. They hinge on the development, and use, by Professor Frank Fenner's Department in the Australian National University, of serological tests for recovered animals (which are solidly immune to subsequent infection by the virus).

The case mortality rate of the disease produced by the stabilized strain of the virus used to initiate the present widespread epizootic is extraordinarily high—over 99 per cent. So long as this case mortality rate rules, only an insignificant proportion of recovered animals is to be expected in the population surviving an outbreak, except when a very high overall kill (resulting in something approaching 100 per cent infection of the population) has obtained. High percentages of recovered animals following mediocre to poor kills point to a lowered case mortality rate.

During the past year, and particularly recently, there have been widespread reports of a noticeable prevalence of rabbits that had obviously recovered from myxomatosis. In addition, in quite a number of specially investigated areas, percentages of recovered immunes have been demonstrated that are disproportionately high having regard to the very moderate overall mortalities recorded. In three of the most recently investigated areas (where the summer epizootic has been observed to terminate rather suddenly when approaching its peak), the percentage of recoveries revealed by the serological tests was staggeringly high.

Some sort of adjustment between the rabbit and the myzomatosis virus was expected in the course of time; but these obvious manifestations have come surprisingly soon. It is impossible to state as yet whether an increase of resistance in the rabbit or a decrease in the virulence of the virus has been the major contributing factor in the reduced case mortality rate.

Apart from the fact that the process of post-parasite adjustment (which must be expected to proceed in the direction that has already become manifest) may reduce the efficacy of myxomatosis next season, there is another cogent reason for making a special effort, during the coming winter to capitalise the present gains in the fight against the rabbit by dealing with residual infestations. The last two seasons have been exceptionally favourable for the widespread breeding of mosquitoes and other insect vectors. A dry or even normal season next year would be reflected in greatly reduced myxomatosis activity. Those regions which benefited during the past summer, or the past two summers, could then look for little help from the disease, however many rabbits were inoculated and released.

Australian National Committee of International Dairy Federation

The setting up of a National Committee to represent the Australian dairy industry on the International Dairy Federation was considered at a meeting in Melbourne in November which was attended by representatives of all sections of the community concerned with dairying throughout the Commonwealth.

The International Dairy Federation had its origin about 50 years ago and Australia has been a member for about 25 years. The objects of the Federation are to further scientific development of all branches of the dairy industry and to encourage international collaboration. A number of special commissions are set up to study and report on particular technical problems from an international point of view; they have made valuable contributions on such matters as markets for dairy products, standards for products and for methods of analysis, and international agreement on production of national cheese types. The most notable activity of the Federation is the holding of the International Dairy Congress.

Hitherto the Department of Commerce and Agriculture has officially represented Australia on the Federation. It is now proposed that this role should be taken over by a National Committee representing all sections of the industry. Steps are now being taken to appoint a Provisional Committee with terms of reference including development of a constitution, exploration of finance and of the possibility of holding the Fourteenth International Congress in Melbourne in 1956.

Importation of Cattle for Northern Australia

Within a period of a few months there have been three importations of new types of cattle which may ultimately have a significant effect on the cattle population of Northern Australia. Directly or indirectly, they all introduce to Australia, for possible recombination, various samples and combinations of genotypes from tropical or semi-tropical countries. Cattle of the Zebu type have attributes of hardiness, resistance to parasites and tolerance of conditions in hot climates which are lacking in British breeds adapted to temperate and more favourable climates. The difficult task of reaching better physiological, genetic and ecological definitions of these attributes in relation to our own environments and of attaining an optimum combination of characteristics from the different, breeds is now being tackled more vigorously.

Only one deliberate importation of Zebu cattle for these purposes has been made before. In 1933 a group of Queensland pastoralists in co-operation with C.S.I.R. introduced 19 Zebus from the Gulf of Mexico. More suitable specimens were not then available for import and their

utilization was not subject to close supervision but their progeny have provided useful information as to the potentialities of Zebu crossbreds.

In the latter part of 1952 two large consignments of bulls and heifers of the Santa Gertrudis breed were introduced from Texas by a private group in Australia which is affiliated with the King Ranch, where the breed was created by amalgamation of Zebu and Shorthorn breeds. It represents probably the most successful attempt to date to combine characteristics from these two sources into a desirable beef breed. The new herd is being established at "Risdon", Warwick, but a number of bulls have already been sold and distributed among pastoral properties.

In December 1952 the first stage was achieved in overcoming the traditional obstacle of quarantine which has prevented drawing Zebus from the main potential source of supply, the Indian sub-continent. Twenty calves, donated by the Government of Pakistan under the Colombo Plan, were selected and subjected to rigid veterinary supervision and were brought in two loads by air-lift to New Guinea where they were maintained under conditions of strict quarantine. The calves represent the Sindhi and Sahiwal breeds which are outstanding among Indian breeds for milk production and docility and they also include some milch buffaloes for trial in New Guinea. The importation was made by CSIRO in collaboration with the New Guinea —Papua Administration. Any introduction of these cattle into Australia proper must await the outcome of extended surveillance of them in New Guinea and approval of the quarantine authorities.

More recently a further small importation from U.S.A. has been executed. Five Zebu and five Africander bulls and heifers have been obtained from Texas and Florida. The Africander is a Zebu type indigenous to South Africa but it could not be obtained directly from that source because of quarantine difficulties. This purchase was made by the Australian Meat Board for use in cooperative investigations by the Board, Queensland Department of Agriculture and Stock and CSIRO on the new cattle breeding research station at Belmont, near Rockhampton. The cattle will be crossed with shorthorns and Herefords for investigations of the adaptation of cattle to Northern Australian environments and definition of important characteristics.

Decentralization of N.S.W. Department of Agriculture

The Minister for Agriculture in New South Wales, the Hon. E. H. Graham, M.L.A., has announced that he is putting into effect a policy for improved, decentralized organization of extension and research services, the aim being to increase the availability of "on the spot" advice to the man on the land.

The State will be progressively divided into agricultural regions, for the grouping of officers therein and, ultimately, the appointment of a Regional Supervisor of Agriculture for the respective region.

The Southern Regional Agricultural Area is now being established with headquarters at Wagga. Mr. John L. Green, who has been appointed to the new position of Executive officer, Co-ordinated Extension Services, will be responsible for the organization of the new area, and for co-ordinating the agricultural services of various Government Departments and instrumentalities. In the case of the Southern Area, the N.S.W. Rural Bank, the Milk Board and the Soil Conservation Service will be all concerned.

As a further step towards decentralization, ten new agronomists are to be appointed to the Department of Agriculture.

Farewell to Professor W. L. Waterhouse

Professor W. L. Waterhouse, noted for his research into the rust problem of wheat and as a university teacher, retired from the Faculty of Agriculture, University of Sydney, at the end of last year. He was given a farewell at the University on 18th December by the Sydney University Agricultural Graduates' Association and organizations of farmers, millers, bakers and others associated with the grain trade. A presentation of a cheque for £1,220 in recognition for his services to the community, was made.

Southern Tablelands "Conference-Tour"

Notice of this tour of the Southern Tablelands and Monaro regions of N.S.W. was given in the September issue of the Journal.

The primary objective of the tour was to discuss the practical application of research results indicating that the carrying capacity could be increased at least three-fold by correcting soil deficiencies, using phosphorus, sulphur, molybdenum and lime.

The N.S.W. Department of Agriculture, as the extension authority for the regions, took the responsibility of organizing the tour, which included representatives from the Department, CSIRO and various other bodies.

The tour commenced at Goulburn with talks outlining the regional problems, particularly those concerning pasture improvement. After visiting CSIRO and the Department's field trials and both improved and unimproved properties in various parts of the region, the members of the Conference assembled at the CSIRO laboratories in Canberra to formulate recommendations for use by their own organizations.

It was stressed that pasture improvement must be accompanied by improved management practices, including fodder conservation, subdivisional fencing and controlled grazing. It was pointed out, too, that the use of molybdenum can promote the growth of many existing improved pastures which have not thrived, in addition to aiding the establishment of new pastures.

The results of this Conference-Tour may be summarised as follows:—

> Where new pasture sowings are made, if there is any doubt as to whether lime or molybdenum is required, both should be used. Two cwt. of lime is to be drilled with

the seed and 2 cwt. of molybdenum-super applied by any convenient means.

Higher application rates of super should be recommended, especially for immediate higher returns per acre, but in some cases it may be desirable to increase the acreage treated at a lower cost of establishment.

Improved areas sown previously should be dressed with one application of molybdenum-super if they are not thrifty.

Clover seed should be inoculated in all cases as an insurance.

Further such co-operative tours should be conducted, and, in particular, one in the Northern Tablelands region at an early date.

The Use of Molybdenum in Australian Agriculture

A summary of information on the use of molybdenum in Australian agriculture has been prepared by the Agricultural Research Liaison Section of CSIRO from information supplied by the State Departments of Agriculture and the Commonwealth Department of Commerce and Agriculture. The summary, which may be obtained on application to the Officer in Charge of the Section, 314 Albert Street, East Melbourne, deals with the acreage of crops treated with molybdenum, the dosage per acre and its method of application. Its future use is also discussed.

New Guinea Resources Survey

Mr. C. S. Christian, Officer-in-Charge, Land Research and Regional Survey Section, CSIRO, and Mr. G. A. Stewart, Senior Survey Officer, will be visiting New Guinea at the end of January, to discuss the organisation of the proposed Resources Survey with the New Guinea Administration.

Dr. R. D. Hoogland, and Messrs. S. J. Paterson and B. W. Taylor will go to New Guinea in March to make a preliminary examination of selected areas. It is planned that the Resources Survey will commence in the Popondetta area in July, 1953.

Agricultural Development in Papua and New Guinea

The Commonwealth Government is placing increasing emphasis on the agricultural development of Papua and New Guinea. The Department of Agriculture, Stock and Fisheries is a key Department in the Administration of that Territory. It already operates a number of agricultural and livestock stations and provides technical advisory services, but is being strengthened and expanded.

One of these stations is the Lowlands Agricultural Experiment Station at Keravat in New Britain, which has 360 acres planted with a variety of crops. Its activities include breeding, selection and propagation of cocoa and manilla hemp, research on the pests of cocoa and coconuts and on the growing of coffee, fibres and native foods, and the demonstration and testing of oil palm, kapok, pepper, cinnamon, vanilla, derris, cotton, caster bean, rubber and native food crops. At the Highlands Agricultural Experimental Station, Aiyura, in the Eastern Highlands the principal experimental work is on cinchona, coffee, tea and native food crops. This station provides coffee and tea seed to planters and produces cinchona bark for use by the Department of Health, in the manufacture of prophylactics for controlling malaria. Observations made at these stations form the basis for advice given to European settlers and to native people by extension officers.

Besides carrying out research to improve the long established crops such as copra and rubber, the experimental stations have been working on the possibilities of new crops. Recent investigations have shown that kenaf, the jute substitute, grows well in the Territory. There are good prospects for the extension of cocoa and experimental plantings of peanuts have also shown promise. Experiments have also demonstrated that the mechanised production of rice on alluvial plain areas has definite possibilities.

Livestock stations in several areas have established herds of dairy and beef cattle, flocks of sheep and goats, and are breeding horses, donkeys and pigs. A veterinary service is being built up with the primary object of eradicating cattle tick from the Territory. Advice on animal husbandry in tropical conditions is given to European stock owners of the Territory and to natives.

Apart from its experimental work some of the most important activities of the Department are extension work amongst the native population whose economy is basically agricultural. The Government emphasises the importance of qualified and experienced staff to carry out its developmental policy. Mr. R. E. P. Dwyer, B.Sc., Agr., H.D.A., H.D.D., was recently appointed Director of the Department of Agriculture, Stock and Fisheries, and staff is being sought for a wide range of new scientific and technical positions which have been created. A number of positions are advertised in this issue of the Journal.

Yanco Irrigation Course

Notice of this Irrigation Course, which was held at Yanco Experiment Farm from October 27th to November 7th, was given in the September, 1952, issue of the Journal.

The Course was arranged by the N.S.W. Department of Agriculture and planned in conjunction with representatives of CSIRO and the N.S.W. Water Conservation and Irrigation Commission. It was attended by over 60 officers, from the mainland States, and representing 14 organisations.

The aim of the course was basically to provide an interchange of knowledge and ideas for extension workers and engineers in the planning and conduct of furrow irrigation. Representatives of many fields of agriculture were brought together, including CSIRO research officers, officers of State Departments of Agriculture, and irrigation authorities.

The course was organized on the seminar principle, which allowed for ample discussion following the presentation of papers. Field excursions were arranged to projects of N.S.W. Water Conservation and Irrigation Commission, the

CSIRO Irrigation Research Station at Griffith, and to farms.

Subjects included the hydrologic cycle, waterlogging, salting and drainage. Consideration of soil properties as a control of irrigation design and practice led to a discussion of water requirements and root zones of irrigated crops, methods of applying water, farm design, land-use and farm management. Other lectures and discussions dealt with the development of irrigation in each state, and the Snowy Mountain Scheme.

Immediately following the course, a party left for a tour of irrigation districts of the Murray Valley, where Departments co-operated by providing officers to conduct the group at each location.

At the final session, members recommended that a similar course be held next year dealing with the application of water to pastures, and including a tour of pasture irrigation districts in Victoria and the Riverina. It was generally agreed that the opportunity to reside together in one building was an immense advantage in allowing more intimate discussion of the subject matter, and in establishing close personal contacts.

United Nations Korean Reconstruction Agency

Mr. T. H. Strong, Director, Bureau of Agricultural Economics, recently returned to Australia after a visit of five months to Korea, as a member of a special mission. The task of this mission, which was composed of specialists from seven nations, was to draw up a 5-year agricultural reconstruction and development program for South Korea for the United Nations Korean Reconstruction Agency, which is now being organized to commence large-scale operations in the fields of financial and technical assistance. The team was organised by F.A.O., and included specialists in irrigation, rice production, marketing and food management, co-operative development, fishing, forestry, extension research and education, and general agriculture. Mr. Strong's particular role was that of Agricultural Economist.

It is expected that U.N.K.R.A. will change the emphasis of United Nations support from purely relief to active reconstruction.

"Towards More Wool"

A CSIRO pamphlet entitled "Towards More Wool: Facts and Pointers from Recent Research" was issued in January, 1953. It is the fourth in a series dealing in non-technical language with various aspects of the sheep and wool research programme which CSIRO and associated institutions have developed since 1946 with funds provided under the Wool Use Promotion Act, 1945.

The first publication of the series provided an outline of the programme as a whole. The present publication deals mainly with material discussed at a school attended by about 30 sheep and wool extension officers from various states, held in Brisbane towards the end of 1951 by the Queensland Department of Agriculture and Stock in association with CSIRO.

The school was organized with the help of the CSIRO Agricultural Research Liaison Section to provide an opportunity for extension officers and research workers to meet and discuss current research in progress, and its impact on current problems of the pastoral industry. The four major topics for the discussions were vital statistics, reproduction, nutrition and drought feeding, and selection.

"Rural Research in CSIRO"

The second issue of "Rural Research in CSIRO" was published in November, 1952, and is available on application to the Officer-in-Charge of the Agricultural Research Liaison Section, 314 Albert Street, East Melbourne. This issue contains a comprehensive review of an important paper by Dr. E. A. Cornish on soil fertility in the Australian wheat belt (Aust. J. Sci. Res. B2: 83-137, 1949). There are articles also on deficiency symptoms in subterranean clover, testing pastures for mineral deficiencies, parasitic gastroenteritis, the harvesting of canning peas, and better pastures for south-east Queensland. Recent research papers are summarised in our agricultural abstracts section, and CSIRO films available on loan are discussed.

The third issue of this new liaison periodical will be published in March or April.

Inservice Training for Extension Officers

An inservice training school for extension officers—the first of its kind in South Australia—was held by the S.A. Department of Agriculture during February at Roseworthy Agricultural College.

The school, which lasted a fortnight, aimed to instruct officers in service procedure and modern methods of agricultural extension.

Film on "Salting and Soil Reclamation"

CSIRO Film Unit has recently released a new film on "Salting and Soil Reclamation." This film is primarily concerned with salting as caused by irrigation, but reference is made to the problem in agricultural and pastoral areas.

Dealing specifically with the irrigation problem, the film points out the importance of using irrigation water correctly in preventing salting. By over-irrigating water is wasted and land ruined. Remedial measures include reclamation of salted horticultural land to pasture, which reduces evaporation from the soil surface and is more salt-tolerant.

The film is intended for extension workers and irrigation farmers. It was made in collaboration with the New South Wales Department of Agriculture at the request of the Department.

BOOK REVIEWS

THE CLIMATE NEAR THE GROUND

RUDOLF GEIGER

Translated from the Second German Edition by Milroy N. Stewart and others. (Harvard University Press, Cambridge, Mass. 1950, 482 + xxi *pp., Price* $5.00).

This translation of a textbook of microclimatology will be of considerable interest for those working in agricultural science. A wide circulation for Geiger's book was recommended by the British Commonwealth Specialist Conference in Agriculture, Australia, 1949.

The book is in two parts, almost equal in length. The first concerns "the microclimate existing near the ground by virtue of its proximity to the ground surface." Its four sections embrace heat exchange near the ground; temperature relationship near the ground; other meteorological elements near the ground and the influence of the ground itself on the climate near it. The second part concerns the "microclimate in its relation to topography, to plants, animals and man" and is in three sections, giving most space to the influence of plant cover. There are 181 figures and 821 references to literature. The German contributions on the subject predominate in the bibliography; there are also contributions from most countries of the northern hemisphere, but from few others.

The author's point of view is that by standardising the placement of meteorological instruments at 1½ to 2 metres above the ground, the recordings so obtained deal mainly with the macroclimate, yet plants especially in their youth are most affected by the disturbed conditions closer to the ground. So by "near the ground" Geiger states (p. xviii) that he means all that is not more than 2 metres from the ground. This explanation really refers to the first part of the book, for in the introduction to the second part he states that the scope of the microclimate to be discussed will exceed the limitation of a 2 metre layer. This wider interpretation allows the inclusion of most of the material in the seven chapters on forestry. Furthermore, although the text is devoted to the climate near the ground it does in fact deal with conditions (temperature, moisture) in and on the ground.

Naturally the two chapters dealing with the microclimate in a low plant cover will be of special interest to those concerned with agronomy, though as Geiger points out (p. 285), their interest also for forestry was one reason preventing their designation as "agricultural climatology".

Much of the author's own work seems to have been concerned with forestry, which probably explains the emphasis on this branch of climatology as compared with the small space devoted to "the animate world and the microclimate", a subject of well known concern to entomologists and of less well known concern to those interested in livestock and poultry. So as to avoid this enormous field, Geiger limits himself to a few pages on microclimate as environmental factor for animals, whereas in his special field—plants, particularly forests—he considers both the action of climate on plants and the interaction. This is summed up in a very useful passage on p. 269, as follows:

> "There is of course an interaction between the plant which depends on the climate of its habitat, and the climate which is partly dependent on the plant. The influence of plants on the climate of their environments increases with their size and with the number of their fellows. At first it is exerted in the realm of microclimate exclusively. But it gradually expands beyond the microclimate to macroclimatic dimensions, as R. Geiger (599) has pointed out in greater detail in a survey of the interaction of weather and the forest. It is no longer a matter of indifference to a country and its macroclimate whether it be wooded or unwooded."

This statement, and the evidence Geiger brings forward to show the influence of forests on climate and microclimate, will be of interest to many scientists, for they revive old controversies and may create new ones. It could be concluded, for instance, that climate, one of the soil forming factors, should not be regarded as having an independent influence on soil formation.

The translation reads very well and there is a wealth of experimental data in the book. Many of the data are given as graphs and diagrams, some of which are rather too compressed for clarity. It is to be hoped that the book will have a wide circulation and that it will inspire readers to survey and extend the Australian contributions to microclimatology.

G. BLACKBURN.

PROCEEDINGS OF THE BIHAR ACADEMY OF AGRICULTURAL SCIENCES

(Agricultural Research Institute, P.O. Sabour, Bihar, India; 3 *copies annually, annual subscription* 10 *rupees).*

This is a reputable journal like many others of the same purpose. It is doubtful if it could be better reviewed than by listing the authors and titles of papers appearing. The list which follows indicates the wide agricultural scope:—Intervarietal hybridization in *Luffa acutangula* (R. H. Richharia); Determination of exchangeable cations (S. C. Mandal); Size and shape of plots in wheat trials (A. K. Mukerji); Fruit producing population of *Papaya* (P. C. Mallik and T. S. N. Singh); Cytological studies in *Loranthus* (R. H. Richharia and P. N. Ghosh); Production of carbon dioxide in wheat infested with *Sitophilus* (B. K. Sinha); Soils of Bihar and their manurial requirements (H. N. Mukerjee).

G. W. LEEPER.

BOOK REVIEW—

SCIENCE AND THE GLASSHOUSE

By W. J. C. LAWRENCE

(Oliver and Boyd, Edinburgh. Second Edition—Revised, 1950, 175 *pp.,* 15/-).

When the John Innes Institution decided to move from Merton to Bayfordbury in 1945, the institution had to design glasshouses which would meet its requirements for plant breeding crops and which would serve as a means of testing improvements in glasshouse design and management. The author of "Science and the Glasshouse" found himself face to face with the unwelcome fact that he had to decide on the design of these houses without any scientific data to guide him. He states that "Science and the Glasshouse" is in the nature of a progress report on research work at the John Innes Institution on glasshouse methods and glasshouse illumination. The work was intensified and extended in 1946 to meet the needs of the institution and the author has performed a fine service in publishing, for the benefit of others, the data he has accumulated. The presentation of the experimental knowledge to replace opinions and to establish *principles* of plant production under glass is a welcome move in a field of horticulture notable for an absence of regard for scientific fact. It is, therefore, gratifying to record the publication of a second, revised edition of this useful book.

Part I of the book deals briefly with the preparation and use of the well-known John Innes composts. Part II deals with methods of cultivation. For example, when should you prick out? Is cold water harmful to seedlings? These and several other questions are answered by statistically controlled experiments, the results of which are summarized at the end of each chapter. In Part III, the author discusses problems of natural illumination in glasshouses and sets out clearly the factors which designers and builders of glasshouses must take into consideration if, in the future, the standard of illumination is not to be the limiting factor in production under glass. The author points out that progress in design cannot be made until standard methods of cultivation have been worked out.

Everyone concerned with glasshouses will find this comprehensive, compact and very clearly written book an invaluable aid and guide to a subject which for too long has lacked scientific investigation.

T. H. KNEEN.

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POSITIONS VACANT

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DEPARTMENT OF AGRICULTURE, STOCK AND FISHERIES

BIOMETRICIAN—£1,238-£1,286.

Qualifications: University degree in agriculture or equivalent degree with honours in mathematics; statistical experience particularly regarding the application of bionomics to agriculture.

Duties: Biometrical and statistical calculations to provide bases for experimental design procedures and significance of results in all phases of agriculture in the Territory.

SENIOR AGRICULTURAL CHEMIST—£1,424-£1,514 per annum.

Qualifications: University degree in agriculture or related science with major in chemistry, extensive experience in control of chemical laboratory research; sound administrative ability.

Duties: Overall administration and supervision of Chemical and Industrial Section covering laboratory investigations, analyses of soils, fodders, fertilisers, insecticides, plant and animal products.

PARASITOLOGIST—£1,334-£1,454 per annum.

Qualifications: Australian University Degree in Veterinary Science, post-graduate parasitological experience including laboratory and field work and control of livestock diseases.

Duties: Conduct parasitological veterinary service; control of parasitic diseases; investigation of animal health and production problems; training of staff.

PATHOLOGIST-BACTERIOLOGIST—£1,334-£1,454 per annum.

Qualifications: Australian Degree in Veterinary Science, Diploma of Royal College of Veterinary Surgeons of the United Kingdom or equivalent qualifications; post-graduate experience (preferably Veterinary), Pathology and Bacteriology; experience field investigations and control of disease of livestock desirable.

Duties: Establish Veterinary Pathological and Bacteriological Diagnostic service for Territory; investigate animal health and production problems; participate in planning control of epizootic diseases with particular reference to exclusion of exotic diseases from South-East Asia; assist development food technology.

ENTOMOLOGIST GRADE II.—£1,286-£1,394 per annum.

Qualifications: University degree in Agriculture or equivalent degree with Entomology as a major subject; post-graduate experience in economic entomology preferably in application of newer insecticides and pest problems.

Duties: Detailed research into specific pest problems of major economic crops including study of their life history, bionomics, economic importance and control measures; taxonomy, field and laboratory work as necessary, application of recent developments in biological and chemical control measures.

ENTOMOLOGIST GRADE I.—£1,238-£1,286 per annum.

Qualifications: University degree in Agriculture or equivalent degree with Entomology as a major subject.

Duties: Taxonomy, field and laboratory investigations, life history studies and pest control, collection and identification of insect specimens; study effectiveness of chemical control and biological importance of specific pests.

AGRONOMIST GRADE I.—£1,238-£1,286 per annum.

AGRONOMIST GRADE II.—£1,286-£1,394 per annum.

Qualifications: University degree in Agriculture with post-graduate experience in Agronomy.

Duties: Design, supervision, recording, and interpretation of experiments covering cultivation fertilizers, crop testing and variety trials with wide range of crops.

PLANT BREEDER GRADE I.—£1,238-£1,286 per annum.

PLANT BREEDER GRADE II.—£1,286-£1,394 per annum.

Qualifications: University degree in Agriculture or Science, preferably genetics as a major subject; post-graduate experience in crop breeding and selection techniques.

Duties: Plant improvements of field and truck crops (fibres, oil seed plants, rice, maize, etc.), to produce high yielding, disease resistant and high quality varieties and strains by self and cross breeding and selection.

SOIL SURVEY OFFICER GRADE I.—£1,094-£1,238 per annum.

Qualifications: University degree in Agriculture with post-graduate experience in tropical soils survey techniques and crops.

Duties: Soil and resources surveys and compile appropriate data, reports and maps; preparation, maintenance and ordering of field equipment.

GENERAL INFORMATION CONCERNING ABOVE VACANCIES

Location: Any part of Papua and New Guinea.

Conditions of Service: The conditions of the Public Service Ordinance 1949-1950 of the Territory of Papua and New Guinea and the Regulations made thereunder apply. These conditions are similar but not identical to those prescribed in the Public Service Act and Regulations of the Commonwealth of Australia. Provision is made in the Ordinance and Regulations whereby certain rights of permanent officers of the Commonwealth Public Service are retained by them in the territorial service.

Taxation: The Income Tax Assessment Act 1936-1950 of the Commonwealth of Australia does not apply to income derived by residents of the Territory from sources within the Territory.

Applications: Applicants should state their full name, date and place of birth, nationality, marital status, war service (if any), present position and salary, and give full particulars of their qualifications and experience. Applications which close on **31st March, 1953**, should be addressed to The Secretary, Department of Territories, Canberra, A.C.T.

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